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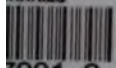
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# CRUDE RUBBER

AND

## COMPOUNDING INGREDIENTS

A TEXT-BOOK OF  
RUBBER MANUFACTURE

By HENRY C. PEARSON

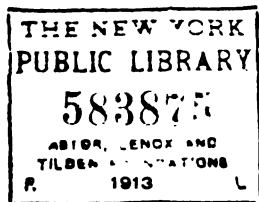
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## PREFACE.

13/11/10

SINCE the first edition of this book appeared, ten years ago, the rubber business has grown notably. New wild sources of rubber have been opened in various parts of the world, and grades of rubber heretofore unknown have come into use. Plantation rubber, previously a negligible factor, has taken its place as a regular and constantly increasing product. Guayule rubber is used by millions of pounds annually. Progress in the reclaiming of waste rubber of all sorts has been constant and of great magnitude. The industry at large preserves the same general outline as of yore, with perhaps the single exception of the making of motor tires, which is a new development and to-day one of the great divisions of the rubber manufacture. Of new compounding ingredients there are many, of substitutes a great variety, and of processes, good and bad, thousands. In the revision of the book those of a real or a suggestive value have been utilized. The general plan of the book has not been altered. It remains a dictionary of compounding facts, an encyclopedia of rubber factory practice. It is for rubber factory use and bespeaks for itself the same favor that it found with the practical man when it first appeared.

The superiority of such a collection over the most comprehensive book of compounds doubtless will be apparent to the expert manufacturer, for this reason. When a manufacturer buys a set of compounds—and most of them are purchasable—he invariably acquires them not so much for use as for suggestion and comparison. The descriptions, therefore, of a great majority of the ingredients used in all lines of rubber compounding, and scores with which he may be unfamiliar, will be so suggestive to the practical man that new sets of compounds will be secured, each partaking of the individuality of the expert, and bearing the impress of the line of work done in the factory to which he is attached, and wholly free from the taint of imitation or counterfeiting, which is the bane of the purchased secret. It is felt that another point of superiority over the

mere compound book will be found in the fact that no private formulas are given, which might wound the feelings of the more conservative manufacturers.

The higher level of prices for crude rubber which has prevailed for some years past has drawn the attention of manufacturers to the pseudo gums—such, for instance, as Pontianak. A number of these are described in this volume, with the hope that, since their presence in the market depends largely upon the insistence with which rubber manufacturers demand them from importers or gatherers, many more may be made generally useful.

In the compilation and revision of this book free use has been made of English, German, and French standard technical works, as well as of technical journals, such as *The India Rubber World*, *The India-Rubber and Gutta-Percha Trades Journal*, the *Gummi-Zeitung*, *The Journal of the Society of Chemical Industry*, and others.

The author takes pleasure in acknowledging his indebtedness for helpful suggestions to skilled manufacturers and superintendents in both America and Europe, and to the following distinguished writers on rubber topics: P. G. W. Typke, F.C.S.; G. S. Jenman, Government Botanist and Superintendent of the Botanic Gardens, Demerara; William Thompson, F.R.S.E.; H. Grimshaw, F.C.S.; W. Lascelles-Scott, F.R.M.S., M.S.C.I.; Richard Gerner, M.E.; Dr. C. Purcell Taylor, Thomas Bolas, F.C.S., F.I.C.; Professor D. E. Hughes, F.R.S.; Messrs. Heinzerling and Pahl, Berlin; Granville H. Sharpe, F.C.S.; Carl Otto Weber, Ph.D.; A. Camille, John H. Hart, F.L.S., Superintendent Botanic Gardens, Trinidad; Sir Daniel Morris, K.C.M.G., Commissioner of the Imperial Agricultural Department for the West Indies; the late Dr. Eugene F. A. Obach, F.I.C., F.C.S., M.E.E.E.; Dr. Joseph Torrey, Dr. David Spence, Herbert L. Terry, F.I.C., and many others.

VAN NOSTRAND

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## CHAPTER I.

### GRADES OF CRUDE RUBBER, SOURCES OF SUPPLY, AND PHYSICAL CHARACTERISTICS.

To an even greater degree than is true of other organic substances, India-rubber is hard to define in scientific language. Its atomic structure is hard to express, and means little when expressed. It is a hydrocarbon, with the approximate formula  $C_{10}H_{16}$ ; but some oxygen is always present, which has led some to believe that oxygen is a necessary constituent. As a rule, however, the presence of oxygen is considered injurious, or a sign of deterioration. Rubber is as readily attacked by oxygen as is iron, and is as surely destroyed. The formula  $C_{10}H_{16}$  is of too general a nature to be of value, since it covers rubbers of widely different physical properties, and even includes Gutta-percha. A more important chemical fact is that rubber is extremely resistant, being soluble only in carbon disulphide, carbon tetrachloride and in the volatile oils, such as turpentine, ether, gasoline and the like.

The physical properties of rubber are softness, toughness, elasticity, impermeability, adhesion and electrical resistance. Its most characteristic, but not most important property, is that it can be repeatedly stretched to many times its length, returning each time to about its first dimensions. No other substance is at all comparable to rubber in this particular property, though one or more of the other properties are possessed in turn by many other substances.

Rubber is derived chiefly from the milk or latex found in the bark of many trees, shrubs and vines, and to a certain extent also in the fruit, leaves, soft wood, or roots. The great families of the *Euphorbiaceæ*, in tropical America, and the *Apocynaceæ*, in tropical Africa, furnish most of the world's rubber. The *Artocarpeæ*, of Central America and the East Indies, have a certain importance, and the *Compositæ*, *Asclepiadaceæ* and perhaps other vegetable families contribute a certain amount. Altogether there are some thousands of species of trees, vines, bushes, weeds,



roots, and tubers which contain rubber; but one genus, the *Hevea* tree, of Brazil, and another genus, the *Landolphia* vine, of Africa—and we should add the *Castilloa*, an American genus—together furnish practically the whole of the world's rubber. The tropics hold a vast store of wild rubber; but transportation, in these regions, is so difficult, and the growth of rubber trees so rapid, that it is becoming easier to grow rubber in accessible places than to get it out of the deeper forests; with the added advantage that plantation rubber is better prepared than would generally be possible in the forest.

The vegetable latex, from which rubber is derived, is most often white, but is sometimes red or yellow. That of several African vines is pink, and the best Gutta-percha latex is as red as blood. The latex is usually thick, like cream, though the solid matter contained may vary from 20 to 60 per cent.

It has never been definitely settled whether the rubber exists as such in the latex, or whether it is developed by the process of coagulation. Some latexes curdle immediately and spontaneously, like blood; others require the addition of chemicals or natural fermentation, like animal milk. In many cases the latex has never been made to coagulate. In some cases the latex is used as food, while in others it may be highly caustic or a deadly poison. When the milk of *Hevea*, the Mangabeira rubber tree, or Balata is drunk freely, it shows no tendency to coagulate in stomach, but is apparently digested. The albuminous substances, which all rubber milk contains, are certainly assimilated by the system, and the other components also seem to be utilized, or at least behave quite unlike rubber.

Another substance developed out of the latex, along with the rubber, is commonly called resin. Some regard this as a broken-down, oxidized, perverted or "unripe" rubber. Other authorities maintain the existence of a series of resin-bearing tubes in the bark, independent of the system of milk tubes, but drawn out with the rubber milk by the same bark cuts.

Rubber is composed of two substances or "principles," one of which, the adhesive principle, is easily soluble in ether, carbon disulphide, and the like; while the other, the nervy or structural principle, is never really dissolved. The adhesive principle cor-

responds roughly to starch, while the nervy principle corresponds to cellulose. The adhesive principle seems to vary directly with the resin content, without being quite identical with it. There seems to be nothing else in nature which even approximates the insoluble or nervy part of rubber. It is this which gives rubber its elasticity, and enables it to take up compound; hence it forms the basis of rubber valuation. The adhesive principle, quite useful in cements and "frictions," forms the basis of a great number of "rubberlikes," and is of much less value.

The classification of the many rubber sources, which at first sight seems such a simple matter, becomes really a perplexing problem before one gets very far into it. The manufacturer must get certain results with his material, and he classes his rubbers according to the results which he has got from certain grades in the past. In buying from the brokers and importers, they must agree on some sort of classification. The only classification which the importer can usually form will be based on geographical origin. He knows where his different lots of rubber came from, and that it about all.

Far away, at the other end of the line, the outfitters, who receive the rubber from the native gatherers, must agree with the natives on some sort of classification and gradation. The native gatherers, among themselves, must learn how to identify those particular trees and vines giving the rubber which sells best at the coast. Then comes the white man with his experiment stations and rubber plantations, demanding a scientific restatement of the whole case. The botanists come along, each working without much regard to the other, with the result that we have about as many scientific classifications as there are botanists. Then comes the man with the business instinct, who aims to bring order out of chaos by getting the manufacturer in touch with the original gatherer, and to thus have one classification for all, based upon the simple principles of economics.

In working out this economic classification, the idea is not to add something new to the existing overproduction of classifications, but to recognize and reconcile the existing ones, saving out that which is common to all. From the standpoint of values, the rubber plantation has greatly simplified the problem. Care in

the preparation of the milk has brought South American tree rubber, African vine rubber, and Ceylon-grown rubbers very nearly to one common level of prices. Nevertheless, this price classification is not final, because tree rubber and vine rubber cannot be used for the same goods in the factory, and different kinds of trees or vines, or even different lots of rubber from the same tree or vine, will give different results in the factory, or in the hands of the consumer.

In the final analysis, it is evident that a common sense classification, based upon vegetable origin, must inevitably prevail. This does not mean a scientific botanical classification, because the botanists are guided by insignificant details of flower, fruit or leaf, leading them to useless classifications. What is needed is a popular or quasi-botanical classification, such as has been extended to apple trees or grape vines. Left to their own devices, the botanists will catalogue a thousand species and varieties of apple trees, but this misleads nobody, because we all know what an apple tree is. This, however, does not apply to rubber sources.

The flower-fruit-and-leaf scheme, necessary to a worldwide classification of the vegetable kingdom, becomes nearly useless as a standard of measurement, when applied to the needs of business in one small corner of the vegetable kingdom, such as the rubber sources. Far better than that would be to adopt the native classifications bodily, since the native is not buried in a pile of unimportant detail, nor lost on the barren stretches of the botanist's "families" and "natural orders." The man in the woods is not interested in corollas, lobes and cell sections, but rather seizes upon some prominent feature, such as an edible fruit or a milky juice or, maybe, a large, copper-colored leaf, and gives the same name to all plants which possess this striking or important feature. For the needs of any one neighborhood or industry, the native classification is of greater value, and is often quite accurate. Some of the scientific botanists have acknowledged the power of close observation and accuracy of judgment of the natives in these matters. To them this kind of botany is even more of a specialty than the botanist's botany is to the botanist. The white man will always do well to learn all he can from the natives around him, because this knowledge will be of immediate use.

Vegetation always adapts itself to its surroundings, so that geographical and botanical classifications have much in common, ultimately tending to coincide. Still, in most cases, any particular bit of forest will have in it a considerable number of very different plants. We are bound to keep in mind that American rubber comes from trees, while African rubber is derived almost wholly from vines. To a certain extent, too, each of the important vines has its own territory, though there is always overlapping, and some species are very widespread.

In the succeeding pages the leading kinds of rubber now on the market are described and classified according to commercial usage, while reference is made also to the geographical distribution of rubber.

South America produces the best rubber in the world and the most of it. The Amazon valley, embracing hundreds of thousands of square miles of rubber-yielding forests in Brazil, Bolivia and Peru, is the center of the industry, the product being exported from the city of Para, whence the name "Para rubber." Two or more species of the *Hevea* produce this rubber, the best known being the *Hevea Brasiliensis*. This, by the way, is the tree now being cultivated extensively in the Far East—to which subject further attention will be given on another page. Peru and other portions of the rubber area also produce a rubber, lower in grade than Para, known as "Caucho," and in some markets as "Peruvian rubber." This is the product of a species of *Castilloa*. Another species, *Castilloa elastica*, is the rubber tree of Nicaragua and other Central American states, which is also found in Ecuador, Venezuela, Colombia, and Mexico, and yields the rubber known as "Centrals." The Atlantic states of Brazil, south of Para, produce other rubber trees, from which come the grades known as "Mangabeira," "Pernambuco," "Ceara," and "Manicoba."

Africa comes next to South America in the amount of rubber produced. "African" rubber is inferior to that obtained from South America, but through improved processes in gathering and curing, the various sorts are delivered in much better condition year by year. African rubber is found on both the east and west coasts and throughout the great basins

of the Congo and Niger rivers, in the Soudan region, and also on the island of Madagascar. The *Landolphia*, of which there are several species, is a giant vine or creeper, from the milk of which most of the African rubbers come. Recently, however, an increasing amount of African rubber has been gained from trees, particularly the *Funtumia elastica*, which yields "Lagos" rubber.

The East Indies to-day furnish but little rubber. The first rubber exported from that part of the world came from Assam, the name of which province has attached itself to rubber from other regions as well. The native rubber tree of India is the *Ficus elastica*. The islands of Java and Borneo, and also Penang and other states in the Malay peninsula, and likewise French Indo-China, produce a certain amount of rubber, mostly from vines or creepers.

Seaports, trading posts from which the first shipment is made, the name of a colony or country, or descriptive terms, as "thimbles" "buttons," "strips"—all or any of these may serve for names of different grades of crude rubber. A complete market report would indicate that there are a great number of different qualities of rubber, many coming from the same source. This, however, is not wholly true. Take, for instance, the Para grades: years ago any rubber coming from Brazil was called Para rubber. Later it was divided into "fine," "medium," and "coarse." Then the rubber from the islands in the lower Amazon became known as "Islands rubber," while that coming from further up stream was known as "Upriver," and these, too, were divided into fine, medium, and coarse. Now a dozen or more local names are applied to rubber from different localities, tributary to the Para market. At the same time, most of these rubbers sell at the same figures, grade for grade, with the exception of coarse.

Something like this is true in the African rubber trade. For instance, a great number of local names are applied to the Congo rubber. The difference between "Equateur," "Kasai," and "Lopori" sorts may not be greater than between different lots from the same place. With a very few exceptions, the names which follow are those used commonly in the leading markets of the world:



PARA RUBBER.

RUBBER is classified at Para and Manaos into three grades, designated by the Portuguese words  *fina*,  *entrafina*, and  *sernamby*. These same grades in the United States are known as "fine," "medium," and "coarse," while in England they are classified as "fine," "entrefine," and "negroheads," the latter being divided to provide for a subgrade, "scrappy negroheads." The proportion of these grades exported through Para of late has been about 61 per cent. of fine, 11 per cent. of medium, and 28 per cent. of coarse.

FINE PARA rubber comes in large bottles or balls and, when cut, shows a surface closely marked with lines corresponding to the number of layers of rubber milk added during the smoking process. These layers are easily separated and, when stretched, are very transparent. This rubber smells not unlike smoked bacon.

MEDIUM OR ENTRAFINE resembles "fine," but is not so well cured, curds and globules of milk not perfectly smoked being found between the layers.

COARSE OR SERNAMBY is made up of the residue, scraped daily from the collecting vessels, or from milk which has curdled before it could be smoked and made into "fine." This grade takes its name from the supposed appearance of the scraps to the mussel fish, called by the Portuguese  *sernamby*. This rubber is known in England as "Negroheads" when in large chunks, more usual in the case of Upriver supplies.

Besides this genral classification of Para rubber, other names are in use, derived from the localities of origin.

ISLANDS rubber is that produced on the island of Marajo, some 17,500 square miles in extent, and other islands in its vicinity in the delta of the Amazon, together with that from other parts of the state of Para, except the Xingu, Tocantins, and Tapajos rivers, which might well be called lower Amazon grades. The Islands "fine" and "medium" rubber is in the form of round or flat bottles, while the "coarse" or "sernamby" is in scraps massed into balls and round cakes, which gives the name "Negroheads" to this grade in the English market.

CAVIANA rubber, named from the island that produces it,

is the highest grade of Islands, and is to-day marketed as a distinct sort. It has a smooth, close grain, and is much in demand for fine work.

CAMETA rubber is so called from the port of that name, on the Tocantins river. It is noted for the superior quality of its "sernamby" grade, the "fine" being the same as from the islands, but rarely seen. This rubber comes in the form of little cups pressed into large "negroheads." It is largely used for mechanicals, and is also suited for white tubing and white toys.

ITAITUBA rubber comes from the port of that name, at the head of steam navigation on the Tapajos river, which enters the Amazon at Santerem. Rubber from this river is distinguished for the rather gutty quality of the "fine" and "medium," and its stringy, dirty "sernamby."

XINGU rubber, from the Xingu river, is noted for the specially good cure of the "fine."

UPRIVER rubber includes the product of the country bordering the Amazon and its tributaries above Para, and that which comes from Peru and Bolivia through the large streams rising in those countries—such rivers are the Purus, Jurua, Javary, and Madeira. This rubber comes to market in biscuits and balls varying greatly in size and shape, a full average biscuit weighing about thirty pounds. The difference in price between Upriver and Islands rubber is due chiefly to the fact that the latter, being derived from more remote localities, shrinks less after arriving in market. Upriver rubber is marketed also under such local names as "Manaos," "Madeira," "Bolivian," "Purus," etc.

MANAOS rubber is named from the city which is the capital of Amazonas, 1,200 miles up the Amazon river, and the center of the rubber trade of district, exported from this port.

MADEIRA rubber, named from a great river which joins the Amazon below Manaos, is of excellent quality and produced in large quantities. It has a finer and closer grain than any other Upriver rubber except the Bolivian.

PURUS rubber comes down the river Purus, the largest of the rubber-yielding tributaries of the Amazon, and is probably the choicest of all the Para grades. A certain amount of the output of the Purus comes from a region formerly belonging to Bolivia,

and was marketed as "Bolivian" rubber. That region has been acquired by Brazil, and organized into the Federal territory of the Acre, which continues to produce a large amount of rubber.

BOLIVIAN rubber is floated down the Beni and other rivers in Bolivia to the Madeira, and thence to the Amazon. It meets innumerable detentions from cataracts in the upper Madeira, on account of which it becomes somewhat dried before reaching market. It has the further advantage of being cured by a better class of labor than is common in Brazil, of having a tougher fiber and of being cleaner than most Upriver rubber, for which reasons it brings higher prices than any other.

Not all the rubber of the Para grades now comes down the Amazon. A certain amount of the Bolivian output is shipped overland to the Pacific, and some by river to southern Atlantic ports.

PERUVIAN rubber, in "ball" and "slab," was formerly applied, in the English trade particularly, to the class of rubber which will be described under the heading "Caucho." In recent years, however, Peru has supplied considerable rubber of the same character as Para—being derived from the same tree and under the same methods—such rubber now forming nearly half the shipments from Peru. This rubber is exported from Iquitos down the Amazon, most of it going to Europe, where it also is sold as "Peruvian." In English market reports, therefore, are now quoted Peruvian fine and negro-heads (coarse), as well as ball and slab, and also "Peruvian weak." The latter is understood to be the product of the same tree as the best Peruvian Para, but on higher lands and somewhat different soil. To a large extent Peruvian fine rubber loses its identity between Iquitos and the consuming markets, and is classed merely as Para. [Described in earlier editions of this work as "Jebe" rubber, mentioned by writers who had applied to it local designations, at a time when trading in it had not become organized.]

MOLLENDON rubber comes from southern Bolivia, being transported by steamers across Lake Titicaca and by rail to Mollendo, a Peruvian port on the Pacific, and thence principally



to England. It is prepared in biscuits and sheets and is marketed at a price between Upriver and Islands.

ANGOSTURA rubber comes down the Orinoco in Venezuela, from Ciudad Bolivar, which town formerly was known as Angostura. It is of the same grades as the Para sorts. Some of the same class of rubber finds its way into Brazil, at Manaos, where its identity is lost.

ORINOCO rubber is the same as "Angostura."

MATTO GROSSO rubber is from the state of that name in the southwest of Brazil, and reaches the market partly through tributaries of the Amazon and partly through the Parana, which discharges into the river La Plata. It comes in "fine," "medium," and "coarse," but principally the latter, little of it reaching the market at present.

CAUCHO, which figures in all the markets of the Amazon region, and in statistics of Para rubber generally, is a distinct sort of rubber, inferior to Para, collected from a species of *Castilloa* instead of the *Hevea* trees. It is not cured by smoking but by the admixture with the milk of lime, potash or soap. The physical characteristics of Caucho, in the main, are the same as the Central American rubbers. The rubber of this sort exported by way of the Amazon formerly was obtained principally from Peru, but it has now been discovered throughout most of the rubber-producing regions of Brazil and Bolivia as well. Caucho figures very largely in the Para rubber trade, the exports in three recent calendar years averaging 18½ per cent. of the whole yearly shipment through Para. It comes to the market in three forms—"ball," "strip," and "sheet" (or slabs)—ranging in value in the order named.

*Caucho* is the Spanish word for India-rubber in general. When this particular sort of rubber first began to be marketed, it was obtained only in Spanish-speaking regions, and on coming down to Para, where the commercial language is Portuguese, and being rubber of a distinct type, it not unnaturally became known commercially by the Spanish name, which really was a most convenient form of describing it, so as to avoid confusion in the trade. The commercial designation of rubber in Portuguese, in use at Para, is *Borracha*.

## CENTRAL RUBBERS.

CENTRAL AMERICAN rubber, or "Centrals," includes that which is produced in all the states north of the Amazon valley, up to and including southern Mexico. It forms a distinctive class, being the product of a tree not native elsewhere. The consumption of Centrals in the United States was larger once than of Para rubber, but the yield has declined gradually to small proportions. This rubber is in good demand for certain uses, ranking in price below coarse Para. It has not the toughness or strength of fine Para, and possesses less elasticity. Centrals are classed usually as "sheet" and "scrap," besides which the terms "strip," "slab," "ball," and "sausage" are used. Greytown being a common shipping-point for Centrals, there is much confusion, one sort often getting substituted for another. Most of the yield of Costa Rica is exported through Nicaragua. The treatment of Centrals generally consists in mixing with the latex the juice of the "amole" vine, often in a hole in the ground, the product being "sheet" rubber. The rubber drippings which adhere to the bark of the tapped trees are peeled off when dry and called "scrap." The trade names below apply to the locality of origin, rather than indicating distinctions in quality.

NICARAGUA rubber includes more than the product of that republic. The real Nicaragua rubber is drier, as a rule, than other grades of Centrals. Nicaragua sheet comes to market in a less clean condition than formerly, and the scrap now brings a better price.

GREYTOWN SCRAP is the best grade of Nicaragua rubber.

GUATEMALA rubber is inferior and unequal in quality. The best is whitish in color, and the lower grades black with a tarry appearance. It is said to be sometimes adulterated with cheap molasses. In curing, the rubber-gatherers pour the milk upon mats to dry, afterwards pulling off the product in sheets, pressing them together for shipment.

GUAYAQUIL STRIP, from Ecuador, is imported in two grades—good and ordinary. Like the Guatemala rubber, the best has a whitish appearance. The inferior sort is porous and filled

with a fetid black liquid, which carries an almost indelible stain.

ESMERALDA rubber, which also comes from Ecuador, is classed as a "strip" and "sausage," the two grades coming to market in about equal quantities.

COLOMBIAN is a pressed strip rubber, dark in color, sometimes showing white when cut. It is graded "No. 1" and "No. 2." Some of the rubber from Colombia bears local designations, besides varying in quality. These include:

*Cartagena*, strip rubber, dark and tough, graded "No. 1" and "No. 2," selling at less than "Colombian." It comes also in thin sheets, rough or "chewed" in appearance, and tarry or sticky. The production has decreased very much of late.

*Panama* rubber, like that from Nicaragua, embraces a wide range of quality. The Pacific mail steamers bring together at Panama rubber from numerous ports, and confusion of grades is a result. What is marketed as "Panama" comes in "sheet" and "strip."

*Virgin* or *Virgen* rubber comes from Colombia in "sheet," "strip," and "slab." It is a product of a different tree from the other "Centrals" described here, and is in demand for the hard rubber manufacture.

MEXICAN rubber is of fair quality, but is received in constantly-decreasing quantities. The grades, listed in the order of their selling value, are "ball" (or scrap), "strip," and "slab."

*Tuxpam strip* comes from the Mexican port of that name. Very little of it is received, and that not of uniform quality.

HONDURAS STRIP is of a quality similar to the Mexican, but is little produced.

WEST INDIAN rubber has a good reputation for quality. It is not produced on the islands, but comes from Venezuela and Central America, and the designation is simply a general trade name used in England.

It is to be kept in mind that the information given thus far under the general heading of "Central rubbers" relates to the native forest supplies from the countries mentioned. The same tree is now being cultivated extensively, and the product, which is

beginning to be marketed, will be considered in another place in this book.

The grades which follow, though not entitled geographically to be included as "Centrals," are in fact so classed, on account of their quality.

MANGABEIRA rubber is so called from the local name of the tree producing it, in some of the Atlantic states of Brazil, south of Para. It is an alum-cured rubber and comes in sheets which resemble slices of liver and are of a tawny red color. The thin sheet sells for more than the thick, as it is drier and better cured. Occasionally it comes in the form of balls. It is exported from Pernambuco, Bahia, Natal, and other points on the coast.

PERNAMBUCO is another name for Mangabeira rubber, derived from the principal state and port from which it is shipped.

SANTOS rubber, from another port, is the same.

CEARA.—The following paragraph appeared in this place in earlier editions of this work: "Ceara rubber comes from a small tree particularly abundant in the Brazilian state of Ceara and is marketed principally in England. The milk exudes from the tree and coagulates in the form of 'tears' which are gathered in scraps and balls. There are three grades, the lowest of which is dirty and difficult to use. Ceara rubber is deficient in elasticity and is hard to vulcanize. It is very dry and free from stickiness." Since this was written the rubber of the region referred to has received much attention, and the output has been greatly increased. This rubber has come to be known more generally by the local name of the tree, "Manicoba," of which there are now recognized to be several distinct species. One of these, found in the state of Bahia, is considered to yield a superior quality of rubber, which is marketed as "Jequie" and "Remanso," these being locality names.

GUAYULE is a Mexican rubber of a distinctively new type which recently has come into use to a very large extent. It was merely referred to in the first edition of this work as "Durango" rubber, and by other names, though at that time it had not been taken up by the trade. This rubber is obtained

from a shrub peculiar to the arid regions of northern Mexico and southern Texas—being practically the only rubber found in the United States—which differs from most rubber producing plants in that it has no latex, the rubber being chiefly in the cells of the bark, a little in the wood, and none at all in the new shoots or leaves. The bark also contains balsam-like resins which are extracted with the rubber and are the cause of its softness and stickiness as compared with fine Para, for example. Generally the extraction of the rubber resolves itself into two processes: one purely mechanical and the other partly mechanical and partly chemical. Whatever process is used, however, results in the destruction of the plant, so that unless means are discovered for reproducing the growth, the practical extinction of the species seems assured. At this writing the exportation of guayule from Mexico amounts to about 1,000,000 pounds per month, the larger percentage going to the United States. To a certain extent the shrub is exported to Europe and America for treatment by various processes, but this is not encouraged by the Mexican government. Botanically the plant is known as *Parthenium argentatum*. "Guayule" may be pronounced *wy-u-le*.

Rubber manufacturers were somewhat afraid of guayule when it first appeared on the market, because of its softness and its slow vulcanizing qualities. They have, however, by learning to use the rubber, overcome most apparent difficulties and find it available for a great many types of goods. For example, it makes an exceedingly strong hard rubber, although it must be combined with a better grade of rubber. It, however, gives a gloss to ebonite that makes very beautiful goods. In mechanical goods, and, indeed, in all soft rubber work, it needs the addition of ingredients that are of a drying nature. For this reason it works exceedingly well with the drier and harder types of reclaimed rubber, and with such intractable gums as Balata. For some months prior to this writing the rubber has been quoted in the market at about 30 per cent. of the price of Islands fine Para.

The various extractors of Guayule rubber have done some really remarkable work in extracting the resin, and producing rubber that comes about as near to being resin-free as any on the



market. For example, one company has produced Guayule containing only 1.06 percentage of resin, which is less really than in Upriver fine Para, which contains normally 1.3. This Guayule rubber is said also to be very transparent, and free from stickiness. At first blush it might be thought, because of the freedom from resin, that the rubber would be equal in quality with fine Para. That, however, does not by any means follow, as the absence of resin does not necessarily presuppose the toughened fiber, the lasting quality, or even the compounding possibilities that Para rubber possesses. It is, therefore, quite possible that an additional toughening process is needed to bring deresinated Guayule up to the standard aimed at. That this can be done is not unlikely, but it must be along the lines that give to Para rubber its extraordinary toughened fiber.

## AFRICAN RUBBER.

AFRICAN rubbers, though comparatively late in becoming known, are produced now in quantities second only to the supply from the Amazon. As a class they are more adhesive and less elastic than Para rubbers, ranking with or below Para negroheads. They often contain a liberal percentage of impurities, and for a long time their disagreeable odor and intractable nature hindered their introduction. But advancing prices for Para grades and fear of their coming scarcity led manufacturers to experiment with African rubbers, until many uses were found for them. The result has been a notable offset to the general upward tendency in price of the Para grades, although there are many purposes for which Africans never have been considered as competing with them. At the same time, the possibilities in the way of utilizing African sorts have not been exhausted, each year bringing out new uses. Besides, more intelligent supervision of the work of preparing rubber in Africa has led to a great improvement in some grades, as compared with the condition in which formerly they came to market.

The African rubbers are obtained from giant creepers, of which there is a score or more species on the continent and in the island of Madagascar, and also from several trees, the most important one of which, discovered first in the Gold Coast Colony,

is known now to be widely distributed. There is now also a considerable production of "root rubber," obtained from underground creepers and marketed as "Lower Congo thimbles," and also as "Benguela," according to the sources of production. The adulteration of African rubbers is not uncommon, being due to the dishonesty, not only of the native gatherers, but doubtless also of some foreign traders on the coasts. But in most of the European colonies in Africa stringent regulations have been adopted to prevent such adulterations. On the Gold Coast the lumps of rubber brought to market by the natives were formerly cut into strips or buttons by machinery, before being exported. Latterly some of this work has been done in England, the rubber then being known as "Liverpool pressed."

As a rule, African rubbers are obtained by the destruction of the trees or vines with the result that the total receipts from that continent are decreasing, despite higher prices than prevailed formerly.

The milk of the *Landolphia* vines, the chief rubber producers of Africa, coagulates on exposure to the air, though in some localities use is made of various astringents, boiling in water, and other methods to assist in preparing rubber. Even where these methods are used, a residue of the rubber sap is left to dry on the bark and in the earth, and is gathered in strings or scraps. The only treatment in some other places is the smearing of the milk upon the bare bodies of the natives, where it dries speedily in the sun, and is easily peeled off. Where rubber trees exist the practice of systematic tapping has been introduced, with a view to preserving the trees, and more scientific methods of coagulation are being tried.

BALL is the classification of a large share of the African rubbers, which comes in every size from three or four inches in diameter down to half an inch or less. "Small ball" of the several kinds differs from the "large ball" in size, and is also drier and affords a smaller degree of shrinkage.

THIMBLES.—The natives, after gathering this rubber, cut it into cubes, about an inch square or less. Thimbles generally contain bark and sand, but very little moisture.

**NUTS.**—Rubber thimbles from Ambriz are quoted sometimes in European markets as "Ambriz nuts."

**LUMP** rubber comes in large pieces, varying in size and of irregular shapes. When packed in casks the pieces often become massed together in transit. It is from the best of the lump rubber that the most desirable buttons and strips are made.

**FLAKE** comes in lumps, livers, and soft irregular masses, and is valuable in the factory chiefly for frictions and for softening compounds.

**PASTE** is the same as "Flake." The Accra flake and Niger paste, which are the same in quality, are at the foot of the list, in respect to prices, the Niger being the cleaner.

**STRIPS** are lump rubber that is sliced and pressed by machinery before it is offered to the trade.

**BUTTONS** is a name applied to rubber similarly treated as in making strips, except that it is cut into small pieces, whereas strips have been marketed in every length up to ten feet.

**BISCUITS** is another name for "Buttons."

**OYSTERS** is another name for "Buttons" or "Biscuits."

**TONGUES.**—Some rubber formerly came to market in long, narrow, tongue-shaped pieces. The same grades are now more frequently seen in the shape of large balls.

**NIGGERS** are of various sorts and from different sources. These rubbers are ball-like in some cases, having the appearance of masses of stringy rubber pressed together between the hands and wound into compact masses.

**TWIST** rubber is not unlike "Niggers" in quality, but shows less shrinkage and differs in preparation and appearance. The string or strip-like pieces are wrapped about each other in order to give a twisted look to the balls.

The list of rubber grades which follows is based upon a geographical arrangement, beginning with the upper west coast of Africa:

#### FRENCH WEST AFRICA.

This is an extensive region, extending from the Atlantic eastward to the precincts of the Nile, from which in recent years a great amount of rubber has come to French markets, the various



grades being designated generally by local geographical names. The leading grades now marketed from this region are :

*Conakry* Niggers.

*Soudan* Niggers and Twists.

*Bassam* Niggers and Lumps.

*Lahou* Niggers.

*Gambia* "A," "A.M.," and "B." These last are of the "Niggers" type.

#### GAMBIA (BRITISH).

*Gambia Niggers* (No. 1, No. 2, No. 3).—These are classified according to cleanliness, No. 1 and No. 2 being fairly clean, and No. 3 containing considerable soil.

*Bathurst*.—Same as *Gambia*.

#### SIERRA LEONE.

*Sierra Leone Twists* (No. 1, No. 2, and rejections).—This is white and amber in color, of low shrinkage, and has bark and grit in it, but little moisture.

*Niggers* (No. 1, No. 2, No. 3) are quite moist. No. 2 and No. 3 contain considerable soil.

*Cake*.—Fairly clean, but wet. It is both red and white, the former bringing the better price.

*Manoh Twists*.—This comes in the shape of tightly wound cords of rubber and works soft. In color it is black or white, the black being the better.

#### LIBERIA.

*Liberian*.—This is graded as Lump, Hard Flake, and Soft. It cuts yellow, is very wet, and is often a soft pasty rubber.

#### ASSINEE.

What is known as Assinee is graded as follows: *Assinee-Silky*, *Grand Bassam*, *Attoaboa*, *Lahou*, *Bayin*, *Half Jack*. It is like Old Calabar, only it comes in chunks three inches square, is wet, and cuts yellow. These names are chiefly used in the English market.

#### GOLD COAST COLONY.

*Gold Coast*.—This is chiefly lump from which Strips and Buttons are made. There are also Biscuits and Niggers (hard and soft). The Flake is wet and has a bad smell, but otherwise is quite clean.

*Accra.*—The Accra lump furnishes Strips and Buttons and is graded "prime," "seconds," and "thirds." The lower grades are Flake and Paste.

*Cape Coast.*—This is another lump from which Strips and Buttons are manufactured and has for lower grades Flake and Soft.

*Salt Pond.*—This Lump is also used in Strips and Buttons, the lowest grade being Flake.

*Addah Niggers* (graded as No. 1 and No. 2) is very similar to Sierra Leone, but generally in smaller balls. It is not an Accra rubber, nor are *Quittah Niggers* or *Axim*. As a matter of fact, the grades from these different ports differ little if any, and are sold most frequently under the head of "Accra" rubber, from the name of the principal town in the colony.

## TOGOLAND.

*Lomi* (or *Lome*) *Ball.*—The best grade of this is a clean, firm rubber and is fairly dry. The lower grades are rarely seen.

## NIGERIA (INCLUDING LAGOS).

*Lagos.*—This lump is also turned into Buttons and Strips, while soft inferior lumps are sold without manufacturing, as low grades. It is very easily distinguished from Accra by its odor.

*Niger.*—The chief grade is Paste, which has an acid smell and is a low grade pasty rubber, wet but clean.

*Old Calabar.*—It is graded as Blue, Lump, and Niggers, and is very bad smelling. The best lump is undoubtedly used for strips and buttons.

*Benin Ball.*—Is generally dirty and has a rotten, woody smell.

## CAMEROONS (OR KAMERUN).

*Cameroons.*—The Ball is graded as large, mixed, and small; the Clusters, which contain some fifty balls, as No. 1 and No. 2; and the Knuckly ball, which is a small dry ball. This rubber has a fairly strong smell.

*Batanga Ball* ("B," "E").—Same as Cameroons, Batanga being the name of a river and country in the Cameroons.

## FRENCH CONGO.

French Congo Rubber is very similar to Cameroons, but the balls are larger.

*Gaboon* is the best known flake and has for additional grades:

Lump, Large "O" Ball, and Small "O" Ball. The Flake is free from dirt and is soft.

*Mayumba* is both Ball and Flake. Another grade known as Mixed is a combination of the two and is sold as second quality.

*Loango*.—Ball.

These are names of rubber stations on the coast. The natives boil rubber milk, adding the juices of vines, and, while the rubber is hardening, wind it into balls, weighing from one-fifth pound to three pounds. The best rubber is not boiled, the milk drying on the wrists of the natives, as they tap the rubber vines. At the coast the balls are cut, to detect any cheating, and washed and packed in casks for export.

BELGIAN CONGO (FORMERLY CONGO FREE STATE).

*Congo* rubber comes in the shape of Buttons, Balls (No. 1 and No. 2), Red Thimbles, and Black Thimbles. The Ball is similar to Cameroons, but tougher. The Dutch Congo Ball is the same as the Congo Ball, but is known as the best grade of that rubber. There is also the Congo (Kasai), Black Twist (graded as fine, mixed, and secondary), and Red Twist. The Strips are among the toughest of African rubbers and are dry, with a woody smell.

From the Lower Congo comes also the *Luvituku*, which is a Red Ball rubber, and from the Upper Congo, the following:

*Upper Congo*.—Ball, Red Ball, Twists, and Strips, all of which is good tough rubber.

*Uele*.—Strips, usually heated and fermented and bad smelling; Cakes, wet, but clean.

*Sankuru*.—Ball, very similar to Congo Ball.

*Lake Leopold*.—Graded as Sausage and Ball. It does not differ from the foregoing enough to warrant special description.

*Equateur*.—In the form of balls (small and mixed). It is dark, dry, and clean, but contains some fermented rubber, which smells badly.

*Lopori*.—Graded as Ball (large and small), Strips, and Cakes. Some of the balls are fine and clean, while others contain fermented milk. Lopori also comes as Sausage.

*Bangui*.—Comes in the form of strips, firm and tough.

*Bussira*.—Ball; a trifle softer than Lopori, but usually of excellent quality and dry. In use it develops a strong smell.

*Aruwimi*.—Ball. This usually comes as large, firm balls, but on cutting them open much of the interior is found fermented.

*Mongalla*.—In this the Ball is similar to Upper Congo Red Ball. It also comes in Strips, and is a good rubber.

Some other designation of Upper Congo are *Kasai*, *Katanga*, *Ikelemba*, *Loango*, *Isanga*, and so on.

*Bumba*.—Ball; *Buki*.—Ball; *Tava* and *Kwilu* are all good Upper Congo grades that are not distinctive enough to dwell upon.

*Wamba*.—This is a grade of Thimbles and is a good black rubber, with only ordinary shrinkage.

## ANGOLA.

*Benguela*.—Graded as Sausage and Niggers. Of the latter, No. 1 is clean and tough, and No. 2 contains a large percentage of red leaf.

*Mossamedes* is practically the same, from a neighboring port.

*Loanda*.—In this the grades, which are Sausage and Niggers, are similar to Benguela, but not so dry. There are also Twists (red and black).

*Ambriz*.—Chiefly Thimbles or Nuts; both are poor grades.

Lately a tuberous root in parts of Angola has been found to produce some rubber. This plant has been described by the natives as "Ekanda."

## EAST AFRICA.

*Uganda* rubber comes from British East Africa. It is a tree rubber, prepared in sheet form under modern methods, and arrives in good condition.

*Mozambique* rubber is that coming from the port of Mozambique, from other ports in Portuguese East Africa, and perhaps from still other places in East Africa. It possesses some properties in common with the Madagascar rubbers. The rate of shrinkage is less than in most African sorts, and good prices are obtained. In the Liverpool market, which is the best for Mozambique grades, quotations are made for Orange Ball No. 1, Ball No. 2, Ball No. 3, Liver, Sausage, Root, Sticks or spindles, Sticks removed, Unripe.

The Orange Ball (resembling an orange in size and shape) is the choicest rubber. Other grades of Mozambique Ball are distinguished further as "white" and "red," the latter being inferior. Its reddish color is due to the fine bark mixed with it. The Unripe contains more bark than rubber, and is not thoroughly cured.

Sticks or spindles consist of spindle-shaped pieces made of slender strings of rubber wound around a bit of wood. Liver (or cakes) is in smooth pieces of irregular size.

*Lamu* Ball, Liver, Sausage, and Root come from the Mozambique port of this name. They are not rubbers of a distinctive sort.

#### MADAGASCAR.

*Madagascar* rubber formerly ranked higher in price than most other African sorts, though to-day the highest price is obtained for some of the Congo sorts. Considering the greater loss sustained in washing, it costs nearly as much at times as fine Para. It is a favorite with manufacturers of hard rubber, on account of the fine lustrous polish which it assumes under the buffing-wheel. The principal classification is between Pinky and Black.

*Pinky* comes in round balls, weighing  $1\frac{1}{2}$  to 4 pounds, black on the outside from exposure to the air, but having a pinkish-white look when cut.

*Black*, also in small balls, when cut shows a dark color, and is more or less sandy and dirty.

*Tamatave* being the principal seaport, its name is liable to be applied to any grades shipped from there. But what is described as "Prime pinky Tamatave" is the best Madagascar rubber.

*Majunga* rubber, from the west coast town of that name, is a dark rubber of special excellence, ranking next to Pinky in price.

*Niggers* (or negroheads) are designated as "East coast" and "West coast," and also as "Red ball," and "Gristly." They generally contain sand and dirt.

*Brown cure* (or brown slab) is a still lower grade.

*Unripe* is the lowest. This term is applied to balls containing bark in the center.

Rubber from Madagascar is sold at French auctions also as



"Lombiro," the native name of a newly found plant, "Morondava," "Barabarja" (names of localities), and so on.

Madagascar rubber is cured (1) by the use of salt water, in which case the water is never wholly expelled, leading to a heavy rate of shrinkage, and (2) by artificial heat. The island is rich in rubber forests, but the exports are restricted by the wasteful methods of the natives, which exhaust the trees and vines, particularly near the coast.

X EAST INDIAN RUBBER.

ASSAM rubber is strong and of firm texture. It is fairly elastic, though often less so on account of carelessness in gathering and the introduction of impurities. There are four grades usually (No. 1 to No. 4), of which the lower ones are extremely dirty and contain soft rubber. The better grades when cut have a glossy, marbled appearance, somewhat pinkish in color. Assam rubber is marketed in small balls, made by winding up strings of rubber dried on the trees, and also in oblong slabs of irregular size, wrapped in plaited straw. The output has declined for several years. Meanwhile the same species has been found in Burma, where the production of rubber has increased, though the whole output of forest rubber from British India is now smaller than at an earlier period.

RANGOON rubber is the product of Burma, exported through the port of Rangoon, and differs so little from Assam rubber as to require no separate description. Four grades are marketed, at practically the same prices as for Assam rubber.

JAVA rubber, from the island of this name, is dark and glossy, of a deeper tint than the Assam sorts, with occasional red streaks. Otherwise, its history and characteristics are nearly identical with those of Assam rubber. Three grades are recognized. The milk dries on the surface of the trees, on exposure to the air, and the shrinkage of the better grades is slight.

PENANG rubber (from one of the states in the Malay peninsula, including the island of Penang) is also very similar to that from Assam. There are three or four grades, at slightly lower prices than the Assam sorts bring.

BORNEO rubber ranks below the other Asiatic sorts, being lower in price, with a higher rate of shrinkage. It is of a whitish

color, changing with age to a dull pink or red. It comes to market shaped like pieces of liver, and is soft, porous, or spongy. The pores are filled with salt water or whey, for the reason that salt is used to coagulate the rubber, and the water evaporating leaves a saline incrustation in the cells. There are three grades, the first of which is a good rubber, while the lowest, when cut, is almost as soft as putty, and is worth little. X

GUTTA-SUSU is a local name applied in Borneo to what is known in the markets at "Borneo No. 3."

#### PLANTATION RUBBER.

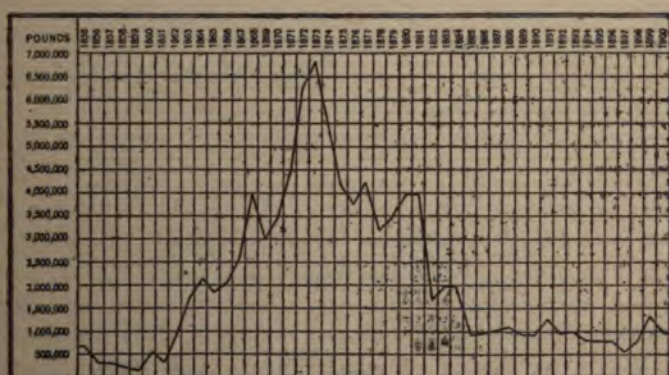
IN the first edition of this work two lines seemed enough to devote to plantation rubber, since so little had then appeared in the market. In fact, with the exception of a few scientists and a smaller number of enthusiastic planters, no one then seemed to regard rubber cultivation as a practical proposition, and the rubber manufacturers were not the least prejudiced against undertakings in this line. The change which has come about in relation to rubber culture, influenced by the continued growth of the demand for rubber, while the extinction of the native supply in many regions seems assured, is indicated by the export of so much rubber already from Ceylon, where there is no native rubber—the product of a *Hevea* species introduced from the Amazon region. It was long supposed that the *Hevea* would not thrive away from the Amazon, but the success noted in Ceylon has been duplicated elsewhere, notably in the Federated Malay States, and *Hevea* species are now being placed under cultivation on every continent. The exportation of cultivated rubber from Ceylon and Malaya has increased at the rate shown by this table, the figures indicating weight in pounds:

	1903	1904	1905	1906	1907	1908
Ceylon .....	41,684	72,040	168,247	327,024	556,080	912,125
Malaya .....	1,000	13,000	228,800	817,769	2,089,085	3,671,435
Total .....	42,684	85,040	397,047	1,144,793	2,645,165	4,583,560

This rate of growth has been most encouraging to the planters, and large estates have been formed with the help of European capital and are being conducted by companies organized on the lines which long have proved so successful in

tea culture in Ceylon. It was estimated at the beginning of 1909 that 300,000 acres had been planted to rubber (mostly *Hevea*) in Ceylon and Malaya, representing \$75,000,000 of capital. The rate of production at that time was such as to lend support to the prediction that when the millions of trees not already producing should reach a tapable size the regions mentioned would alone be in a position to supply as much rubber as now enters into the world's total consumption. Para (*Hevea*) rubber has been planted also in India and the islands of Java, Sumatra, and Borneo, and other varieties to a large extent in Mexico and Central America (mostly *Castilloa elastica*), in several colonies in Africa (chiefly *Manihot*, otherwise "Maniçoba"), and particularly in the Congo Free State (*Landolphia* vines and *Funtumia* trees). Rubber is being planted likewise in Hawaii and the Philippines, in southern Brazil, New Guinea, and elsewhere.

Any fear of overproduction of rubber, through the coming into "bearing" of so many planted trees, is offset by the fact that thus far the sources of wild or forest rubber, with the sole exception of the native *Hevea* (Para) trees in Brazil, are being exhausted by the extraction of their product. Where trees and vines are killed by the rubber gatherers, there may be an increased yield from a given country for awhile, due to the working of new areas from time to time, but ultimately the principal forests are overrun, after which the output falls off. A diagram is introduced to show how the export of Colombian rubber grew





rapidly until it reached a high figure, after which it declined as rapidly to the low figure which has since prevailed. The same result has been seen in many other countries, and to-day the total output of African rubber is less than formerly for the same reason as in Colombia, while native rubber has almost disappeared in Assam.

It would seem that manufacturers ultimately will be forced to adopt plantation rubber to a large extent. Thus far their opportunities for experimenting with plantation products have been confined chiefly to *Hevea* rubber from Ceylon and the adjacent states, and this has come into widespread use, having been adopted by most manufacturers. The cleanliness of plantation as compared with forest rubber has been an attraction from the beginning, and the higher price paid for the former has been due to its greater content, bulk for bulk, of rubber. But it has proved deficient in strength as compared with the Brazilian product. For some purposes the deficiency of nerve of the new rubber has not proved a disadvantage, as for instance in solution making, in which it has been used largely. Gradually it has replaced Para in many other applications, but as yet not for cut sheet, thread, and elastic bands.

Rubber from *Hevea* plantations was at first clearly not identical with the product of the same species under forest conditions. The question was discussed whether this difference was due to the plantation rubber not being smoked, as is done with Brazilian rubber. A reason now more generally admitted is that, owing to the tapping of planted trees having been begun at a very early age, the product was "immature." At least plantation rubber can now be had with more strength than formerly, which may be due either to increased age of the trees or to better methods of collection, coagulation, and care in subsequent storage and shipment.

PLANTATION or PLANTATION PARA is the term applied in the trade to the new class of rubber. "Ceylon," "Malaya," or "Straits" are also applied, but these are merely local designations, indicating no difference in quality. What is more important is the growing practice of planters of stamping their product with trade marks, by means of which buyers may know absolutely

the source of any particular purchase, which is helpful when a producer of several tons in a year is attempting to establish a reputation for quality. The number of such marks is too great for them to be enumerated here. Plantation Para is marketed in various forms, as follows:

*Biscuits.*—Prepared by allowing the rubber milk to set in shallow receptacles, with or without acetic acid, and washing and rolling the cake of rubber which appears at the top more or less circular in form—usually  $1/16$  to  $1/8$  inch in thickness and 10 to 14 inches in diameter.

*Sheets.*—Formed in the same way as Biscuits, but rectangular in outline. On account of their shape they lend themselves to more economic packing. Biscuits and Sheets are sometimes pressed together to form blocks.

*Crepe.*—This rubber, on account of the washing and tearing which it undergoes between the rollers of the washing machine used in its preparation, contains a minimum of impurities. It has an irregular surface, is uneven in thickness, and, like Lace or Flake rubber, dries rapidly. On account of the washing which some manufacturers subject all rubber to, it has been questioned whether the extra labor involved in its preparation will be paid for by the extra price realized. Prepared in lengths of 3 to 6 feet, and widths of 5 to 12 inches, and graded according to color.

*Worms.*—The product obtained by cutting irregular sheets of freshly coagulated rubber into thin worm-like rods, shears or machinery being used. By passing the dry Worms through ordinary washing rollers they are bound together into an even strip of Crepe.

*Lace.*—Very thin perforated sheets of considerable lengths. It comes from the machine in a continuous strip, and is cut into pieces 6 feet long as it runs on to wire trays. It is sometimes pressed later into Biscuits or Sheets.

*Flake.*—Obtained by placing small pieces of freshly coagulated rubber in a small rolling machine or washer, the corrugations of which run horizontally; the rollers are close together and the cut rubber issues as thin strips.

*Block.*—Made from pressing together Sheets, Biscuits, or other forms of rubber, in a freshly coagulated or partly dry

state, in sizes usually 10 x 10 x 6 inches, the chief purpose being to reduce to a minimum the surface exposed to the air after preparation.

*Scrap*.—The remnants obtained after tapping, rolled into balls or made up into cakes. It is shipped with or without other preparation; it is sometimes made into Crepe. It brings a comparatively high price.

The popularity of the various forms here described may be indicated by these statistics of the offerings of Ceylon and Malaya plantation rubber at the London auction of December 31, 1908: Crepe, 877 packages; sheets, 202; block, 128; biscuits, 59; worm, 12; scrap, 35; total, 1,313.

The color of Plantation Para is also taken into account. In England paleness is considered important, pale and clear rubber, or even amber color, selling best.

RAMBONG is the native name in the Far East for the tree *Ficus elastica*, which produces the Assam rubber of commerce. A considerable amount of cultivated *Ficus* rubber, from Java, Ceylon, etc., is sold under this name. This comes in Crepe, Sheet, and Block.

MANICOPA plantation, and CEARA plantation are the product of the cultivation, in southern Brazil, of the various species of *Manihot* mentioned already under the heading "Ceara rubber."

CEARA plantation, from the same species, comes from Ceylon and Malaya, and from some German colonies in Africa.

MEXICAN plantation, as this book is issued, is coming into market in increasing quantities, some of it very clean, and not differing otherwise in quality from the product of the same tree (*Castilloa*) under forest conditions. The higher price of this grade, as in the case of other plantation rubbers, is due to the smaller percentage of shrinkage. Mexican plantation rubber comes as Strips, when the latex is creamed, coagulated, and run between rolls, and as Grena when the product is scrap-picked from the cuts on the trees and coagulated only by exposure to the air.

*Trinidad* plantation, *Tobago* plantation, *West Indies* Plantation *Central American* plantation, *Guayaquil* "*Castilloa*," and such terms relate to the product of cultivated *Castilloa* trees in

the regions indicated. A certain amount of *Castilloa* plantation rubber comes from Ceylon.

CONGO plantation, from various species, comes from Belgian Congo (Congo Free State).

UGANDA plantation comes from British East Africa.

#### COAGULATION.

THE primary process that rubber undergoes when it enters a rubber mill after weighing, is washing. As a rule this is done with clear water. At the same time, certain acids and foreign substances that are contained in the rubber are not easily soluble in water, and yet may be easily removed. The first thing to do, therefore, is to know what is to be expected in various grades of rubber.

There is no question but that the differences between varying grades of rubber, besides being due to a somewhat different chemical composition, are also due in a measure to varying methods of collection and coagulation. It is undoubtedly true that no one method of collection would be best for all kinds of rubber gathered, even if it were possible. At the same time, it is of interest to the practical rubber manufacturer to know pretty nearly what systems are pursued, and particularly what ingredients are added, to produce coagulation, as the presence of certain residues may affect his compounds.

SMOKING rubber is the system with which the world at large is most familiar, and is practised in the Amazonian forests in the collection of Para gum. Several kinds of palm nuts are used to produce a thick smudge, but those ordinarily used are from the Urucuri palm (*Attalea excelsa*). This smoke has been found by analysis to consist mainly of acetic acid and creosote, the latter being a well known preservative of rubber. Fine Para rubber is nearly always smoked in this way. Coarse Para is air dried. Ceara rubber is also, to a certain extent, smoked in the gathering, the palm nut used being that of the *Eucturbe edulus*. There is also a kind of gum tree found in the forests of the Isthmus, and where it is impossible to get palm nuts, its wood is used for the coagulating smoke.

AMOLE JUICE.—A native process for coagulating the milk of

the rubber tree, which prevails throughout Central America, involves the use of an alkaline decoction made from the juice of a plant called "achete" or "coasso" (*Ipomæa bona-nox*, Linn., and also *Calonyction speciosum*). This is combined with rubber milk in the proportion of 1 pint to 1½ gallons of the latter. During coagulation the vessels are often heated from 165° to 175° F. After coagulation, the rubber is dried for twelve or fourteen days. The kinds of rubber coagulated in this fashion are Mexican, Nicaraguan, and in fact almost all of the rubbers that come under the head of Centrals, and are obtained from the *Castilloa elastica*.

ACETIC ACID.—Used in coagulating *Hevea* latex in the Far East.

ALCOHOL.—One of the best general coagulants, but too costly to be commercially available.

ALUM.—This is used all through the isthmus of Panama, and in coagulating Accra rubbers and other African sorts. Pernambuco rubber is also treated with a water solution of Alum, as is the Nicaraguan at times.

BOSANGA.—The juice of the *Costus afer*, a seed, used in the coagulation of the latex of *Landolphia* in the Lopor district in Central Africa.

BETA SEPARATOR.—The invention of Mr. John Hinchley Hart, F.L.S., of Trinidad. This is an arrangement by which the latex placed in the upper compartment is washed, filtered, and coagulated. The machine known as the Beta separator works somewhat on the principle of the cream separator.

COUTINHO'S MACHINE.—This is a wooden cylinder about 20 inches in diameter, set horizontally, revolving by a crank and 30 arranged that smoke is let into the inside through the cylinder shaft. The latex, by the revolution of the cylinder, is distributed over its inner surface and there smoked and coagulated.

COYUNTLA JUICE.—This is an astringent juice made from the Mexican weed of that name. When the rubber milk is gathered, it is placed in earthenware vessels and whipped with the weed, which causes coagulation. The Mexican rubber known as Tuxpam is treated in this way.

CENTRIFUGAL SYSTEM.—Another form of coagulation, that has recently been tried with considerable success, is the using of



a centrifugal machine which removes the watery contents from the gum, and produces a marvelously clear elastic rubber.

DANIN'S machine for smoking rubber is a revolvable cylinder, through openings in the end of which smoke is forced, the latex first having been introduced through the other end of the cylinder. The cylinder being rotated, the latex spreads itself over its inner circumference and is carried past the discharge end of the smoke conduit and thus coagulated. The machine is the invention of Joao Roso Cardoso Danin, of Para, Brazil.

FORMIC ACID.—Used instead of acetic acid in coagulating *Hevea* latex.

FUMERO.—A machine patented by G. van den Kerckhove, of Brussels, Belgium. The apparatus is simple, the latex being guided by the hand over the smoke and the rubber produced in ball form uniformly cured. The apparatus designs to do scientifically exactly what the Amazon rubber gatherers do crudely in smoking Para rubber.

HEAT, AIR, SUNLIGHT.—Various rubbers are coagulated simply by the exposure to slight artificial heat, to the sunlight, or merely to the air. Such are the coarse Para rubbers, certain of the Centrals, African, and East Indian rubbers. Fiji rubber is coagulated in the mouths of the natives, and some Angola rubber on the arms and breasts of the natives.

HELPER PROCESS.—This consists of the addition of a solution of acetic acid, and is based on the knowledge derived from the analysis of the smoke of the Urucuri nuts.

KOALATEX.—A proprietary preparation used in Ceylon and the Federated Malay States for coagulating the latex of the *Hevea Brasiliensis*.

LIME.—A final process in the coagulation of rubber in India is the washing over with lime. Collins also mentions the use of lime in connection with the coagulation of Para rubber.

LIME JUICE.—Lagos rubber and some other African sorts are coagulated by the addition of a little lime juice, which is added as the milk flows from the vine.

NIPA SALT.—A salt obtained by the burning of the plant known as the *Nipa fruticans*. Is used in the coagulation of Borneo rubber.

**MACHACON JUICE.**—Cartagena rubber, which is gathered carelessly, is coagulated in a hole in the ground by the addition of the juice of the root of the "machacon"—a strongly alkaline solution.

**POZELINA.**—A preparation intended to keep rubber latex in a fluid condition until the time of curing. The ingredients used in making the preparation are secret. The headquarters for its sale are at Para, Brazil.

**PURUB.**—Another name for hydrofluoric acid, when prepared as a coagulant of rubber latex.

**SALT.**—Many kinds of low grade rubber are coagulated by the addition of salt or brine. Borneo, for instance, is coagulated in that way. Madagascar rubber receives a treatment of salt-water. Mangabeira rubber is treated with a mixture consisting of 1 part of salt to 2 parts of alum. Nicaragua rubber is also often coagulated with salt.


**SERINGUINA.**—A chemical product for retarding for any length of time the coagulation of rubber latex. Is said to contain no corrosive elements. When the latex is finally smoked the substance evaporates entirely. It is the invention of Dr. Cerqueira Pinto, of Para, Brazil.

**SOAP and WOOD ASHES.**—The medium grade rubbers all through Central America are often coagulated by the use of soap. and where that is not plenty, of a strong lye from wood-ashes.

**SPIRITS OF WINE.**—This is used sometimes in the coagulation of Balata.

**SULPHUR FUMES.**—According to James Collins, rubber of the Para varieties is sometimes exposed to the action of the fumes of melted sulphur, which affects coagulation. This process, however, is very rarely followed.

**TORRES SYSTEM.**—In addition to the natural methods described above, there are several that give some evidence of an intelligent study of the milk and the substances best adapted for this work. Under the Torres system a liquid is made by a secret formula, from the roots and fruits of certain South American palms, which, when added to the milk, preserves it from curdling, so that it will keep for weeks. It can thus be transported to a convenient place for smoking.



## OXYDASES IN RUBBER.

WHY rubber is dark in color may with propriety be treated here. The discovery by Dr. David Spence, whose investigations of the latex of various rubber trees have been most profound as well as practical, of an active enzyme which has an oxidizing effect, is of much interest to rubber manufacturers. The result of this line of experiment and research will undoubtedly one day be a pure crude rubber with all the nerve and strength of the present dark colored product. Dr. Spence's description of enzymes is here appended:

"These enzymes are probably, as I learned, present in the protein of the latex of all rubber producing plants, and so act upon the insoluble portion of the protein that it is converted into colored products, which impart the dark color to the rubber. In my original work I determined that the temperature at which the oxidizing enzymes are destroyed lies very close to the point where in general other similar enzymes perish. To obtain rubber only slightly darkened, it seems, at first glance, only necessary to destroy the active enzymes in the latex or the rubber by heating above the sterilizing temperature,  $75^{\circ}$  C. But this method of destroying the enzymes by means of heat is not so easily accomplished in practice, and this fact leads me to the belief that in the latex and in the rubber there was a heat-resisting agent, zymogen, which slowly changed into active enzymes.

"I found, for example, that freshly cut pieces of Para rubber, washed thoroughly with water for more than an hour to remove the strongly colored soluble matters, gradually darkened and after exposure to the air finally became entirely black. Potassium cyanide, a mercury chloride solution or acetic acid, failed to prevent the dark coloration, or at least after the above solutions were completely removed by washing. I made many experiments with the latex of *Funtumia elastica*, but found without exception that heating the latex or the rubber prepared therefrom even to  $100^{\circ}$  C. for half an hour was insufficient to alter the tendency to turn dark.

"It is known that certain natives on the West African coast obtain rubber from the latex of *Funtumia elastica* by heating it with water until the separating rubber particles coalesce into



balls. Nevertheless, I have seen no sort of rubber prepared in this manner in which the effect of the active oxydase enzyme was not plainly observable.

"Since the oxidizing enzyme is very stable towards heat, the best method for handling the latex to secure only faintly colored rubber appears to be the one presented previously by me and now repeated here. By this method the enzyme itself is to be removed as completely as possible before coagulation. The latex is diluted with water before the coagulation and the agglomerating rubber particles washed well (this applies at least to *Funtumia elastica*) in order to remove the oxidizing enzyme as well as other foreign matter from the rubber. In this manner a snow-white rubber is obtained. Yet to prevent as much as possible the baneful effects when using the boiling process a substance having a noxious action against the enzyme but a harmless one towards rubber could be utilized.

"Many experiments to discover a body which would render innocuous the oxidizing enzyme have been fruitless. So, from a practical standpoint, the destruction of the oxidizing enzyme is not as simple a matter. There are a number of difficulties to overcome, and, only when the nature and properties of the enzyme are more closely investigated, may we hope to ascertain a practical method for the removal of this substance."

**SYNTHETIC RUBBER.**—Every year there is more or less newspaper prominence given to Synthetic Rubber discovery and discoverers, but so far absolutely nothing has been accomplished commercially. The producers of alleged Synthetic Rubber work along a variety of lines. There is, first and most dangerous, the line of fraud where real rubber disguised is put forth as a cheap synthetic production. This procedure has been the means of extracting many dollars from the pockets of the credulous. There is another class of honest but somewhat ignorant inventors who make products that in some respects are similar to rubber, and which they believe are equal to or even better than rubber. They use oils, gums, cellulose, in fact, almost anything that will produce a waterproof plastic. These products are often of value in connection with rubber and sometimes when used alone, but never yet have anywhere near equaled the crude material.

## CHAPTER II.

### SOME LITTLE KNOWN RUBBERS AND BASTARD OR PSEUDO GUMS.

FROM time to time reports come in from all over the tropical world regarding the discovery of gums, some of which are similar to India-rubber, while others are more like Gutta-percha. In a few instances these gums have appeared on the market, in due time, under various names and have been useful. This is not the rule, however, and it is due to a variety of reasons. The first, perhaps, is the scientific attitude of those who primarily examine the samples received at the great centers of civilization. Unless gums are of high grade, and bear promise of being nearly as valuable as a good grade of India-rubber or Gutta-percha, they are usually pronounced as worthless, or nearly so. These same experts, it is well to remember, condemned reclaimed rubber and substitutes, which may lead the manufacturer to suspect that his wants are not always appreciated by the learned. It is possible, of course, that the scientists and experts are right, and that it would have been better had reclaimed rubber or substitutes never been known. Nevertheless, rubber manufacturers are ever in the market for them, and would welcome many of the pseudo gums and find large uses for them, if once they were within reach.

Aside from the scientific attitude is the indifferent attitude of the gatherers in their native wilds, of the importers who see little profit in such cheap gums, and of the manufacturers themselves, who wait until a neighbor has tried something new before venturing to experiment.

It is only sufficient to recall what is needed in rubber compounding to see how many of these gums could be made valuable. For example, sometimes simple stickiness is called for, in another case only insulating qualities and stickiness, in still another, waterproofing qualities and stickiness, and, it is well to add here, where only one valuable quality exists in a gum others can often be supplied. As a matter of fact, in the present state of compounding and manipulation, the presence of resins is not heeded, short life can be overcome, and intractability can be done away with.

A few years ago an American rubber manufacturer attempted to secure from Mexico a quantity of the bark from a small tree which was believed to yield rubber, with a view to extracting the gum, by the boiling process. His agent, not understanding the instructions given, had enough of the shrubs cut off at the ground to make a steamer load, and shipped them entire—wood and all. A liberal yield was obtained of a gum equal in quality to a good grade of Centrals. The undertaking did not prove profitable enough, however, to cause it to be repeated. But in time others became interested in the product of the plant in question, with the result of developing the present large production of Guayule rubber, which is treated more fully in another chapter.

It is with the hope that some of the gums mentioned in the following pages may be brought before the rubber manufacturers the world over, that space has been given to them.

ABBA RUBBER.—This is an African rubber, from Lagos. It probably is the product of the *Ficus Vogelii*. It is low grade rubber and cures soft and short. There is a large percentage of resin in the milk. The tree is widely distributed, and the product is thought to enter largely into Lagos rubber. The trees are most abundant in Grand Bassam, and grow rapidly to great size, single trees often yielding 10 or 12 pounds in a season. The milk is coagulated by adding vegetable acids and boiling. The rubber is bright red. It contains about 55 per cent. rubber and 45 per cent. resin, and forms 30 per cent. of the latex. The washing loss is 10 to 14 per cent. One report is that the latex of this tree is mixed with that of *Funtumia elastica*, the mixture being called by the natives "aba-odo."

ABYSSINIAN GUTTA.—An adhesive acid gum of an earthy brown color, similar to common gutta in external appearance. Softens in water, but keeps a very great elasticity. On drying it remains exceedingly adhesive, therefore could not be used in place of Gutta-percha, but with proper treatment would undoubtedly make an excellent friction gum.

ALMEIDINA.—This comes from West Africa, particularly from the Cameroons and Angola, and has been found in the Solomon Islands. Its source is a shrub with succulent stems, all of

which are tapped. The milk is boiled and the resultant balls dried in the sun. It comes to market in small and sulphur-colored nodules, resembling potatoes, for which reason it sometimes has been called "potato gum." When broken open, these balls look like putty, and although quite brittle when cold, the gum easily softens in warm water and may be drawn out in threads, which are possessed of some elasticity. It is completely melted at 240° F., and remains rather sticky after melting. It almost completely dissolves in cold benzine; in fact, nearly all of the solvents ordinarily used in rubber manufacture dissolve it. It mixes and dissolves with rubber in almost any proportion and up to 25 per cent. at least. Not only does it not injure the rubber, but is said to be beneficial to it. In working on the mill a pungent vapor arises from the mass, which, however, has no poisonous effect. In using this gum, a little caustic soda sometimes is added to the water when it is being washed; some manufacturers add tannic acid. Animal or vegetable fixed oils do not dissolve Almeidaína, and therefore when mixed with it are apt to rot it. Mixed with Gutta-percha this gum is practically indestructible. The name "Almeidina" is that of the first important shipper of the gum; in England the spelling "Almadina" has come into use. The gum is known also as "Euphorbia gum." Warburg and Jumelle say that Almeidaína comes from *Euphorbia rhipsaloides*, which must not be confused with *E. tirucalli*. Berry gives Almeidaína 82.78 per cent. resin, and 9.40 per cent. hydrocarbon.

AMAZONIAN RESIN RUBBERS.—The valley of the Amazon contains various trees and plants that are caoutchouc producers, but which are generally neglected, as the gatherers are seeking the more valuable *Hevea* or *Castilloa*. At the same time the latex of some of these plants has been referred as being used to a considerable extent for adulterating Para rubber. Among these are mentioned the trees known under the native names of Amapa, Sucuba, Surva, Tamanguiro, Molango, etc. All of these show a marked percentage of resin in the milk.

ANTIPOLO GUM is being made from *Aartocarpus incisa* (the breadfruit tree) in the Philippines. Antipolo is a town in the province of Luzon.

BAKA GUM.—Found in the Fiji archipelago. Comes from

*Ficus obliqua* (Foret). Used by natives for birdlime. Milk very abundant. Gum little known. Samples sent to England were reported upon as being suitable for mixing.

BANANA RUBBER.—Green bananas yield considerable latex, which is 95.7 per cent. water and only 3.9 per cent. rubber. It is easily coagulated by boiling. Made from *Musa sapientum* and *M. paradisiaca*.

BARTA-BALLI.—One of the best known native trees in the Guianas. The milk of this tree has usually been mixed with Balata milk and is said to give it its reddish tint. The gum when dried by evaporation is rather sticky and soft, but when precipitated in alcohol is dry and firm. Reports from England are rather condemnatory as the gum is said to absorb a great deal of water in washing, which it retains very obstinately. The same rubber, dried by precipitation by spirits of wine, is said to be very brittle. Known also as Cumaka-balli.

BEIRA RUBBER.—Another name for stick rubber, gathered on the east coast of Africa, and shipped from Beira.

CANOE GUMS.—From the bark of the breadfruit tree, which is found so plentifully in the islands of the Indian archipelago, comes a thick mucilaginous fluid which hardens by exposure to the air. When boiled with cocoanut oil it makes a tough rubber-like substance wholly waterproof, and very lasting. It is used ordinarily for waterproofing seams of canoes, pails, etc. It is also used, when fresh, as a birdlime. Is probably from the *Artocarpus integrifolia*.

CAPE CATTIMANDU.—Derived from an *Euphorbia* found at the Cape of Good Hope. The juice is so acrid as to give intense irritation to any part of the body with which it may come in contact. The gum has been used as an anti-fouling dressing for ships' bottoms, but is little known otherwise.

CATTIMANDU GUM.—This is one of the *Euphorbia* gums, the natives using the milk as a cement to fasten knives in their handles. Under the influence of heat it becomes soft and viscid and when dry is very brittle. It is probably about as useful as Indian gutta. Found in Vizagapatam, India, Cattimandu gum seems to be from *Euphorbia trigona*.

CATIVO GUM.—This comes from the sap of the mangrove,



called "Cativo" in the United States of Colombia. The gum is fluid at 130° F., and if the temperature be raised to 212° F. it is easily filtered and impurities removed, and a somewhat objectionable smell greatly lessened. The gum is then of a clear reddish brown color. It mixes easily with rubber and is said to produce a very tough compound. When vulcanized with 5 per cent. sulphur, this gum makes a fine, elastic product. When vulcanized with more than 5 per cent. sulphur, it becomes like Gutta-percha, and can be sheeted or molded, when warmed.

CHICLE.—A gummy resinous substance found in the *Achras sapota*, a tree growing abundantly in the warm damp regions of Mexico and also in portions of Central America. Chicle should be of a whitish color, odorous, and free from impurities, but often is adulterated with an inferior pink or reddish soil. It is solid and brittle at ordinary temperatures, but becomes plastic when placed in hot water. It is quite soft at 49° C. (120° F.). It is used chiefly in the United States in the manufacture of chewing gums, and to a small extent in England for adhesive plasters. It has been used for modeling purposes and for mixture with India-rubber for insulation work. The fruit is about as large as an apple, though looking more like a quince and is eaten under the name of "sapodilla" or "sapotilla" plum. The fruit is pricked or sliced and the latex is allowed to ooze out without squeezing, so as not to get the other juices. Lateral tapping is used on the tree, and 15 to 25 pounds of milk or 5 or 6 pounds of gum may be obtained in one season without injuring the tree. The milk is coagulated by boiling. Prolonged boiling makes it reddish, though some trees are said to yield a red gum. The best Chicle is made from highland grown trees. The trees sometimes grow 70 feet high, and the wood, which is very heavy, takes a high polish and is quite valuable. The analysis of Chicle shows 44.80 per cent. resin, 17.20 per cent. rubber, 9 per cent. water, and 8.20 per cent. starch and other matters, on an average. It sometimes contains as much as 55 per cent. of resins, when dry.

COORONGITE.—Sometimes known as Australian Caoutchouc. An India-rubber like material, discovered first near Salt creek, a short distance from the coast of South Australia. It was observed in little hollows of sand and resembled patches of dried

leather, but it generally occurred in the swamps. It is supposed to be of the petroleum series. Some scientific authorities in England and America ascribe to it a vegetable origin and regard the gum as exuding from a plant or lichen. It is not soluble in the ordinary solvents used in rubber work, but after mixing with India-rubber it can be put in solution. According to Forster, it vulcanizes somewhat as India-rubber does.

**COW TREE RUBBER.**—The Cow Tree is very plentiful in tropical South America and yields a milk commonly used for food. This milk contains considerable Caoutchouc, which is about 30 per cent. resin. Botanically it is known as the *Brosimum galactodendron*. Besides *Brosimum galactodendron*, Warburg mentions another Cow Tree, *Couma utilis*, an *Apocynaceae*, growing in northern Brazil, while *B. galactodendron* is an *Artocarpeae* of Venezuela. *Couma utilis* latex contains rubber, and is used by the natives in waterproofing. Cow Tree milk is exceedingly hard to coagulate, and evaporation product is completely soluble in hot acetone, seeming to indicate absence of any rubber. The constituents are mainly fatty matter, possessing neither tenacity nor elasticity, according to the German chemists.

**CUMAI RUBBER.**—From the milk of a tree found on the Rio Negro and Uaupes, in Brazil. None comes to market. This milk is used by the natives for waterproofing purposes.

**DURANGO RUBBER.**—See Guayule.

**EUPHORBIA RUBBER.**—See Almeidaia.

**FLUVIA.**—See Pontianak.

**GOA GUM.**—Discovered by Senor Da Costa. It is a gum that comes from the Mival-cantem, which grows wild in the Coucan district in Brazil, and is also planted for hedges. Chocolate in color, softens under heat, is easily molded, and thoroughly waterproof.

**GUTTA BASSIA.**—Found between Upper Senegal and the Nile. Has the appearance and apparently many of the properties of Gutta-percha. Softens in warm water and becomes glutinous at the boiling point. Is soluble in sulphide of carbon, chloroform, benzole, and alcohol. Can be kneaded in water as easily as ordinary gutta. It may be the same as Karite gutta, which is



from *Bassia Parkii*, though there are other African *Bassias* which are said to yield good gutta.

GUTTA-GREK.—A gum that comes from Palembang, in Straits Settlements. It appears very much like India-rubber, but is permanently softened and destroyed by heat sufficient to melt it. It smells like Gutta-percha rather than India-rubber.

GUTTA HORFOOT.—This is a vegetable juice sent in sealed tins from the Straits Settlements, which yields a material like India-rubber of fair quality. No way of coagulating the juice, where it is gathered, seems to be known.

GUTTA-SHEA.—Said to be the nearest approach to Gutta-percha among African products; obtained from the Shea, Galam, or Bambouk rubber-tree (*Butyrospermum Parkii*). The butter is the solid fat contained in the seeds and is used in making hard soaps. Gutta-shea is separated from the fat in the course of the soap making and is found to be present to the extent of from 5 to 75 per cent. A kind of Gutta-percha is also obtained from the trunk of the tree in small quantities. Also known as "Karite gum." Analysis of the butter shows: Guttalike 25.20 per cent.; resin 57.13 per cent.; water 5.04 per cent.; impurities 12.63 per cent. The yellowish butter smells and tastes much like cocoa butter. Casalbo claimed to have differentiated two varieties, one yielding a red and the other a yellowish gum. The red kind is the more valuable, and this tree also yields gum from its trunk, while the yellow gum tree does not. It is uncertain whether the yellow butter yields any gutta, though the trunk gutta from the other variety is comparable to Red Borneo in toughness and in its structure. Called also "Karite Gutta" and "Shea butter." Knowledge on this subject is still confused and the authorities conflict. The two varieties are called "Shea" and "Mana," the Shea being the one which yields gutta, and also the more abundant variety. The branches seem to yield even more than the trunk. The milk is allowed to stand in the open air for about 24 hours, when it partially curdles. The crystalline particles are then kneaded into a mass in hot water. However, reports on this gum are conflicting, and it is probable that two sources are confused. Some advices seem to point to the plum-like fruit as

the source of both gutta and butter. Fendler and Heim consider Karite gutta worthless as a substitute for Gutta-percha.

GUTTA SUSU.—Also called "Gutta grip," at Singapore, and formerly known as "Assam White." The washing loss is 30 to 45 per cent., and the clean rubber contains 14.5 per cent. resin. In Java and Sumatra it is generally stored under water. The vine is tapped and the gum left to dry on the bark. The milk is sometimes gathered and coagulated with salt and boiling, but this method is not so good as bark drying. It is a white and remains so under water, but darkens on exposure to the air.

JELUTONG.—See Pontianak.

JEVE, JEBE, or HEVE (hence *Hevea*) was the ancient name for rubber among the natives of Ecuador. The name was applied to a rubber coming principally from the neighborhood of Iquitos, Peru. (See Peruvian rubber.)

JINTAWAN.—A bastard Gutta-percha mentioned by Thomas Hancock in four patents and also by Taylor and Duncan. Probably a mis-spelling of "Djintaan soesoa," the same as Gutta-susu.

LORANTHUS RUBBER.—A sticky non-elastic Venezuelan product. Contains 18 per cent. of resin.

MABOA GUM.—Said to be produced from a species of *Ficus* in Santiago de Cuba.

MACWARRIEBALLI GUM.—A rubber gathered in British Guiana from the *Forsteronia gracilis*. From the report of the director of the Kew gardens, to whom a sample was submitted, it would seem that, while the gum is at present unfit for use in place of ordinary Caoutchouc, because of its stickiness, it might be of value in cements, frictions, and the like. *Forsteronia gracilis* is a vine or bush rope belonging to the *Apocynaceæ*. The milk appears to be often mixed with that of Balata or Barta-balli, though Macwarrieballi is more like rubber than Balata. The vine is very rich in latex.

MANGEGATU GUM.—This comes from Vizagapatam, India, and is a gum of the bastard gutta type, similar to gutta trap, and is said to come from the *Ficus Indica*.

MANDARNVA RUBBER.—A low grade of South American gum, somewhat like Ceara rubber. Little known. Is said to grow on the dry arid uplands of the interior. Is one of a number

of gums that bear the natives names, "Cauchin," "Pau," and "Massaranduba."

MANGA-ICE RUBBER.—Argentine republic. It is very abundant. Produces good rubber.

MUDAR GUM.—This comes from an *Asclepiad*, commonly known as gigantic swallow wort (*Calotropis gigantea*). The shrub is found throughout the southern provinces of India and grows to a height of from six to ten feet. Produces a gutta-like substance, which becomes plastic in hot water, and in other ways acts somewhat like Gutta-percha. It insulates badly, but is recommended for waterproofing. Analysis: Rubber, 16.92 per cent.; rosin, 83.08 per cent., according to Warden (1885). Hooper found 25.54 per cent. of a rather poor rubber, and 62 per cent. resin.

MULE GUM.—Another name for Ceara rubber.

MUSA RUBBER.—A gum expressed from the peel and leaves of the banana and pisang plants. No gum yet on the market. Process patented in England by Otto Zurcher, of Kingston, Jamaica. Also called "Banana Rubber" (which see).

NEEN RUBBER.—A rubber-like gum said to be produced by an insect, reported from Yucatan. The insect belongs to the coccus family, feeds on the mango tree, and swarms in those regions. It is of considerable size, yellowish brown in color, and emits a peculiar oily odor. The body of the insect contains a large proportion of grease, which is highly prized by the natives for its medicinal properties in skin diseases. When exposed to great heat, the lighter oils of the grease volatilize, leaving a tough wax which resembles shellac. When burnt this wax produces a thick semi-fluid mass, like a solution of India-rubber. An "ant wax" or lac is found in Madagascar, and is secreted by two insects, *Garcadia Madagascariensis* and *Gascardia Perrieri*. The former secretes a white gum, containing 52 per cent. of resin. The latter secretes red gum, with 46 to 48 per cent. resin. The two gums have the same value.

PALA GUM.—Found in Assam and Ceylon. The wood and the bark are valued in India for their medicinal qualities. The tree yields an abundant milky juice, which after coagulation acts something like Gutta-percha. It readily softens in hot water

and takes impressions, which are retained when cold. Also known as "Indian Gutta-percha." Comes from the *Dichopsis elliptica*. It has been used as an adulterant of Singapore gutta for some years. It was used also as birdlime or cement and keeps well under water. Is hard and brittle when cold. The resin or crystalban is easily removed by boiling alcohol, and the residue appears to be a very fair gutta.

PALO AMARILLO.—A varnish-like gum from the latex of the Mexican tree *Euphorbia fulva*. Analysis of the latex gives 34 per cent. gum and 6 per cent. resin. So far the gum is not susceptible of vulcanization and is not elastic.

P. F. U.—A good rubber, not now obtained commercially, the source of which was the Colorado desert weed, the *Picramnia floribunda utilis*.

PICKEUM GUM.—See Guayule.

PONTIANAK is a cheap inelastic gum imported from Borneo for use as a friction and filler. It takes its name from the town of Pontianak, and is known also as "Jelutong," this being the import name in the United States, and sometimes as "Fluvia" and "Gambria." It is white and looks like marshmallow candy, and smells strongly of petroleum. Oxidizes readily on exposure to the air. Pontianak gum, according to eminent authority, comes from the tree *Dyera costulata*. It often comes mixed with the milk of local *Willoughbeias*. The *Dyera costulata* sometimes grows 150 feet high and yields 100 pounds of gum when cut down. Pontianak is about the same as Almeidina in quality. Berry finds in Jelutong 75 to 76.55 per cent. resin, and 16 to 19 per cent. hydrocarbons. Pontianak wood is much used in making Chinese shoes.

ROOT RUBBER.—A rubber obtained from the roots of semi-herbaceous plants known as the *Carpodinus lanceolatus*, *Landolphia Thollonii*, and others. Very abundant in the open grassy country of Angola and the Congo Free State. (See Thimbles.)

SARUA RUBBER.—Found in the Fiji archipelago, from *Alstonia plumosa*. Formerly collected largely, now but little comes to market. Natives take no interest in its collection. Is soft at first, but hardens after a time and becomes inelastic. Is about the color and consistency of putty. Natives collect juice in three months



and it coagulates almost at once. Comes from stems and leaves. No juice in trunk of tree.

SIEBA GUM.—See Tuno.

SUSU-POKO (meaning English tree milk).—A gum from a tree growing in the Malay peninsula, used in the place of Gutta-percha, after being cleansed and treated with chloride of sulphur. Mentioned by Leonard Wray in 1858.

TALOTALO GUM.—Found in the Fiji archipelago. Comes from *Tabernaemontana Thurstoni*. The gum is hard, gutta like, and without elasticity. Also called "Kau Drega." The milk is thin, but the tree grows large, up to two feet in diameter, and it is the best rubber source in the Fiji islands.

TALAING RUBBER.—An almost black rubber which, when cut into, is white and porous presenting a honeycombed appearance, the cavities being filled with a watery fluid. It is quite tough and elastic and appears to be of good quality. It comes from a creeper which is abundant in the Philippines, in Malacca, and Indo-China. The juice is very abundant, and is coagulated by being boiled in water.

TIRUCALLI GUM.—This is a Euphorbium gum, from the Indian plant known as milk hedge. The milk of this plant is used for various purposes, chiefly medicinal, in India, and has been suggested as a substitute for Gutta-percha. Like Gum Euphorbium, it has a very acrid character, and the collection of it is a very dangerous operation to the eyes. When dry it becomes very brittle, but when warmed in water is quite elastic.

TOUCHPONG GUM.—This is without doubt a rubber gum, entirely distinct from Balata. The rubber dries in strips on the trees, and what little of it comes to market has not been recognized as a distinct sort. Samples sent to England, however, have been favorably reported on. It is found throughout the Guianas. Probably from *Sapium biglandulosum*. Spelled "Touchpong" by Jenman; "Touchpong" by Morris; "Pouckpong" by Dr. Hugo Miller.

TUNO is a trade name applied to a gum gathered principally in Nicaragua and Honduras. It is the product of what has been called the "sterile rubber tree" and also the "male rubber tree" of Nicaragua. The milk is coagulated with the aid of heat. The

gum is but slightly elastic, is very sticky when heated, and is cheap. It is used as a friction gum, and is also mixed with Balata in the manufacture of belting. Sometimes it is sold under the name "Seiba gum," its identity being lost by the ingenious massing and manipulation under water. Nicaragua rubber adulterated with "Tuno" in coagulation soon hardens and loses its elasticity. Also spelled "Toonu" and "Tunu." It is derived from *Castilloa*, *tunu*, and called locally "caucho macho" or male rubber. Though it has a bad reputation, Mr. E. Poisson has drawn excellent rubber from this same tree in Costa Rica. Tuno gum usually runs over 80 per cent. resin. Berry gives it 80 to 86.13 per cent. resin, and 3.50 to 7.06 per cent. hydrocarbons (gutta-like).

YELLOW GUTTA.—This comes from the Sunda Isles, from the genus *Payena*. It is practically a compound of India-rubber with two resins. One of these is crystallizable and the other is pitchy. If the raw material be treated with boiling alcohol the resins are taken off and the remaining product appears to be good India-rubber. Berry describes Yellow Gutta as "a gum of dual composition containing the hard resins characteristic of chicle, and the elastic caoutchouc-like hydrocarbon characteristic of rubber." It is more like rubber than gutta. The analysis gave 80 per cent. resin and 12.58 per cent. hydrocarbons (rubber?). The resin looks like chicle resin, and has a saponification value of 104.1, with a trace of acid. However, there are several guttas which are yellow.

## CHAPTER III.

### I. DIVISIONS IN RUBBER MANUFACTURE AND PRIMARY PROCESSES IN MANIPULATING THE GUM.

THE foremost European manufacturers of rubber goods, as a rule, make everything in the line of compounded rubber, hard or soft, and in addition often are producers of Gutta-percha goods. In the United States, on the other hand, the tendency has been to specialize the industry, and as a result it has divided itself naturally into the following general lines: Mechanical rubber goods; Tires, pneumatic and solid; Molded work; Sundries, druggists', surgical, and stationers'; Dental and stamp rubbers; Surface clothing; Carriage cloth; Mackintoshes and proofing; Boots and shoes; Insulated wire; Hard rubber; Cements; Notions; Plasters; and Reclaimed rubber.

The following brief description of the manipulation of rubber in these various lines is given simply because there are superintendents and managers who are experts in one line, say, for example, of Druggists' sundries, but who may be wholly unfamiliar with even the machinery used in other lines.

**MECHANICAL RUBBER GOODS.**—This line of rubber manufacture, which is also known in Europe as technical rubber goods, embraces all the heavier combinations of India-rubber, metal, and fabric which are used in engineering and industrial lines. It covers, for example, belting, packings, hose, and special articles of almost endless variety and description.

This portion of the rubber business has always been the pioneer in the production of new compounds, new processes, and better and heavier machinery. Its manufacturers always have welcomed new grades of rubber, have been the first to utilize those that were a drug on the market, because of lack of knowledge as to their manipulation, were familiar with the uses of reclaimed rubber while yet other lines were simply considering its use, and with hundreds of compounds and cures, with a broad knowledge of industrial achievement in all lines, they have often pointed the way for manufacturers in other lines to follow, to the betterment of their goods or their pockets.



The mechanical rubber goods factory has, to begin with, the same general outfit in the way of machines for manipulating the crude gum as have the other lines. Their mixing mills, however, are often heavier, and their calenders run at higher speeds, while they have, in addition, enormously heavy hydraulic belt presses, huge vulcanizers, and scores of special machines designed for individual problems required for their line of work, or perhaps for a single factory alone. The kind of vulcanization used in this work is (1) open steam heat, where the goods are buried in French talc or wrapped in fabric; or (2) dry heat, where they are confined by molds, and held in a steam press during the cure; or (3) where the goods, as in the case of belts, are molded between the platens of the press itself, while curing. Even in this line of work there are some concerns that only do special parts of it. For example, there are certain large factories that make only certain types of packings, which have a world-wide sale, and on which they are run continuously. Many of these mills also are large producers of tires.

**BOOTS AND SHOES.**—The manufacture of rubber boots and shoes, although apparently a simple business, not only requires large capital, but is one that has often been overtaken by disaster. It is a matter of common knowledge that, given the same compounds, the same machinery, and the same skilled workmen, no two mills are able always to turn out exactly the same grades of goods. Quality is one ingredient that may or may not be added to the goods, no matter how honest the endeavor. That there are reasons for this, no one can doubt, and that the day will come when this branch of manufacture will be an exact science is probably true. That, however, will entail a definite knowledge of rubber from the moment it first sees the light as creamy liquid exuding from the tree, through every event in its life,—in coagulation, transit, storage, factory manipulation, compounding, calendering, curing, its death in the service of man, and its later resurrection in the process of reclaiming. Nor is this all. There will be a need for exact information regarding the ingredients added in the course of compounding, their relation one to another, mechanically and chemically, so long as they be joined together. This, coupled with atmospheric and

climatic conditions, not to say a profound knowledge of the errors and accidents due to the ignorance, prejudice, or carelessness of the ordinary workman, constitutes so complex a problem that successful manufacturers to-day feel fairly safe in frankly stating to would-be competitors that they have no need to hide their formulas, as they are but a small part of the problem.

In the complete rubber shoe plant there are found, for initial equipment, washing rolls, mixers, refining mills, and calenders such as most of the other lines employ. In addition, there are special calenders, with engraved rolls for shoe-upper work; others, also, with engraved rolls for soleing; presses for molding boot heels, sole-cutting machines, and, of course, vulcanizers. As this class of goods is cured by what is known as the "dry heat"—that is, by being confined in dry, hot air for several hours—it will readily be seen that it is a radically different business from mechanical rubber goods, for instance. These dry heaters are simply large air-tight rooms, fitted with steam pipes for heating, lined with tin, double walled to prevent radiation, into which hundreds of pairs of boots or shoes are run on skeleton cars, to undergo the process of vulcanization. The manufacture of rubber footwear in brief, therefore, consists in washing, drying, compounding and calendering the rubber, the cutting of the calendered sheets into various shapes for cementing over lasts in the shapes desired, the varnishing, and the dry heat cure.

DRUGGISTS', SURGICAL AND STATIONERS' SUNDRIES.—This part of the rubber business entails more skillful manipulation and more finesse in manufacture than almost any other line. An atomizer bulb, for example, must be graceful in shape, with delicately smooth surface, of good color, and either of the non-blooming variety or so near it that the sulphurous efflorescence will be so slight as to pass unnoticed, while in mechanical goods a length of garden hose may be of any color, may bloom until crusted with sulphur crystals, but if it "stands up to work," it is the best, and is beautiful in the eyes of the trade.

The question of colored rubber is one that has interested this branch of the business from its inception. In none other is so much white rubber made and, incidentally, none others get such good effects. This insistence by customers for white goods and

by physicians for black containing no trace of lead has entailed a deal of trouble upon this trade, for the manufacturers until recently could not go into the open market and buy a high grade of white recovered rubber, while of black there is ever an ample supply, and in black goods to suit the physician he is forced to substitute a dry bulky vegetable black for oxide of lead or white lead, and then not get so good a result.

The machinery used is very similar to the equipment of a mechanical goods factory, but the scale is smaller. Washers, grinders, calenders, tubing machines, steam vulcanizers, and small steam presses are the machines used. Naturally special machines are employed in certain parts of the work, but their use is limited to a few factories and to comparatively insignificant specialities.

The feature in this trade which stands out most distinctly from other rubber lines is perhaps the manufacture of hollow work, as atomizers, syringes, breast-pumps, and a host of other balls and bulbs. The parts for these are cut from sheets of compounded rubber, cemented together at the edges, inflated to the general shape of the mold and cured in an open steam heat. In order that the ball may perfectly fill the mold during the cure, a few drops of water or a little ammonia are put inside of it which, swelling under the heat, develops pressure enough to perfectly shape it and add to its outer surface the finish found on the inner surface of the mold.

The difficulties that manufacturers in this line experience in making perfect goods are legion, as they are in other lines. They are added to by the fact that the trade, as already indicated, demands articles of beauty from a gum that was designed for utility solely. A trace of black in a white compound may spoil hundreds of dollars' worth of goods, nor can such trace be rubbed off, scoured out, or eradicated, after vulcanization. Hence, the whites, blacks, reds, and other colors must be mixed on separate mills, and the trimmings and scraps kept sedulously apart.

Pure gum—that is, rubber compounded only with sulphur or some other vulcanizing agent—is also largely produced in this line. For example, it makes what is known as dental dam, the pure sheet used by dentists. This is generally a sulphur compound cured in open steam. Certain manufacturers, however,

practice the vapor cure with good success in making these goods. This cure gives a beautiful finish, but if it be not done with great skill it may be disastrous to both the workman and the goods.

Dental dam, surgical bandages, and stationers' bands represent the highest priced and least compounded goods, while stopples, erasive rubber, and common tubing represent the other extreme. Between the two is a latitude that allows of a variety of combinations and compounds that no man can number.

CLOTHING, CARRIAGE CLOTH, MACKINTOSHES, and PROOFING.—This business may be handled, in a measure, as the mechanical goods business is; that is, the gums mixed by heat on ordinary mixers, and then spread by calenders on the fabrics which give the articles their strength. This is the manner in which rubber surface clothing is run. The machinery is simple, since, in clothing, the parts are cemented together and cured in dry heat. In carriage cloths, after calendering, the goods are grained on embossing rolls, varnished, and run into a dry heat.

The mackintosh and proofing business, however, is somewhat a departure from this. Here the gum, after mixing dry, is usually put in churns with a cheap solvent, and reduced to a solution. It is then applied to the cloth with a knife spreader.

For double-texture work, a simple doubling machine brings two surfaces together. A portion of the business that has divided itself from the rest, is what is known as proofing for the trade. Here manufacturers simply coat the cloth and sell it to others, who make it up into garments, or anything in fabric or rubber for which there may be a call. The mackintosh manufacturer to-day not only is familiar with a great variety of rubber gums and ingredients used in compounding, but is also an expert in fabrics, as his business is really closely akin to the tailoring business.

TIRES.—Although the tire business seemed at first to be a natural part of the mechanical rubber goods business, it really proved itself, later, to be a business wholly distinct from it. Even the large manufacturers of mechanical goods who began tire

making on a considerable scale, keep this part of their business distinct from other branches as a rule, running it as an entirely separate department. A large business is done in pneumatic tires for bicycles and motor cycles, but it is much surpassed by the production of pneumatic automobile tires. The knowledge gained through the manufacture of pneumatic bicycle tires (which, by the way, was one of the hardest problems that the rubber trade ever solved) has proved wonderfully effective in developing the skill necessary to make this heavier and more important article. This tire, like the bicycle tire, is built up of frictioned duck, with an outer coating of high-grade rubber carefully vulcanized. While a variety of compounds undoubtedly is used in its manufacture, it is hardly possible that any manufacturer will be able to sell a very low grade of goods. In other words, the life of the tire is so important, and the purchaser so anxious for a good article, that adulteration or cheapening to any great extent is not a danger. An adjunct of this business is the manufacture of inner tubes which has assumed very large proportions.

The general machinery used in making tires is the same that is used in the work of preparing rubber in the other lines. There are two general classes of tires manufactured, however: those that are molded, and those that are made in such a way that they can be wrapped for the process of vulcanization. Wrapped goods, of course, are cured in an open heat. In the one case the tires are cured in presses, sometimes in nests of molds, and sometimes in vulcanizers. Various ingenious and valuable processes and special machines have been invented, and are now in use in this line. An industry that has grown up in connection with the tire business, and that has increased the practical knowledge of the uses of the rubber wonderfully, is that of tire repairing, which is carried on in many places and to an important extent outside of the rubber factories proper.

A part of the tire business that is of great interest is the making of the solid or cushion molded tire used on light vehicles. A very large business is done in this, the work being a simple process of mixing the prepared compound, forcing it into shape through a tubing machine, and molding. Of even greater importance has been the business of producing heavy



solid tires for trucks, motor buses, fire engines, and freight wagons. Many rubber manufacturers have specialized in this line and their yearly product is very great.

**INSULATED WIRE.**—The manufacture of insulated wire, either with India-rubber or Gutta-percha insulation, is a line that is more distinctly apart from other portions of the rubber business than almost any other. For Gutta-percha, the general machinery used is described in the chapter on that gum. Where India-rubber is used, the crude gum is treated in the same way as in mechanical goods. It may be forced over the wires by tubing machines, or welded together in strips that are run between grooved rolls.

Braiding machines are also a part of the outfit for weaving the protective covering, and the wire is usually wound on huge drums and vulcanized in open steam heat. Polishing machines, testing machines, and various mechanical contrivances are, also, a part of this equipment. The line of compounds used is one adapted almost wholly to this industry, and embraces a great variety of ingredients and gums that are treated specifically under their special heads, elsewhere in this book.

**MOLD WORK.**—A part of the rubber business that belongs either to the mechanical or to the druggists' sundries line has, during the past few years, detached itself from the rest, so that to-day many large factories are run simply in producing small mold work. They have the usual equipment of rubber machinery, special appliances for filling and emptying molds, and the usual aggregation of hard and soft metal molds that run into thousands of dollars in a short time. The extent to which this business is carried may be imagined when it is known that one company runs 300 presses on this work, and many have from 20 to 50 in constant service. When it is remembered that very rarely are two compounds exactly alike, it will be seen that, in this line also, the expert compounder has a wide field for thought and experiment.

**HARD RUBBER.**—In spite of the hundreds of substitutes for vulcanite, or hard rubber, that have been produced, the demand has in no way fallen off, and mills are running full to-day on the

production of this semi-metal. The old fashioned compound, consisting of 2 pounds of India-rubber to 1 pound of sulphur, is still in use in certain goods. Modern progress and chemical knowledge have, however, added a great many compounds for specific uses, so that almost any degree of quality, or hardness, or price is now furnished on call.

The business, primarily, is a simple one, the hard rubber machinery being like that used in other lines. In the manipulation of the gum for vulcanization, and in its finish, however, special machines are necessary. The finishing machines are lathes, saws, buffers, etc., somewhat similar to what might be used for turning hard wood. The mechanical factories often do a little in hard rubber in the line of valves, and the druggists' sundries mills often make their own syringe fittings, but the bulk of the business in America is done by mills that make only vulcanite the year around.

**CEMENTS.**—Many rubber factories are run wholly on this line of work, the gums being mixed as in a general rubber business, put into solution in churns, and sold by the barrel for an infinite variety of purposes. Hundreds of different formulas are in use for cements sold for general and specific purposes. The leather shoe business, for instance, calls for a dozen or more special cements. The bicycle business has need for a great many grades of what are known as tire cements. Stickiness, waterproof qualities, durability, and cheapness in their goods are sought by all cement manufacturers, and, in order to secure these qualities, skill is demanded in compounding in no way inferior to that shown in other lines of rubber work.

**DENTAL AND STAMP RUBBER.**—The manufacture of unvulcanized gums for the use of dentists and rubber stamp manufacturers is an industry apart from other lines, and one that has assumed large proportions. The rubber is compounded and sold by the manufacturer, and cured and finished by the dentist or rubber stamp manufacturer. In stamp work the rubber is compounded for soft rubber and many hundreds of tons are sold during the year while, of course, the dental rubber is so mixed that under the cure it becomes vulcanite of the color desired.

The machinery for this work consists chiefly of washers, mixers, and calenders.

NOTIONS.—A department of the rubber business, the importance of which is not generally appreciated, is that which takes in such work as waterproof dress bindings, dress shields, childrens' aprons, diapers, etc. Several large factories manufacture these goods, mixing their rubber by the usual processes, coating it on calenders, and having special machines for forming and curing the goods in their special shapes. In the manufacture of dress shields, the vapor cure is often practiced very successfully. The rubber manufactures of this class are not by any means inexpert compounders. They have also, perhaps, gone as far as any in deodorizing rubber goods, so that the smell of the gum or any compounding ingredients is wholly done away with.

PLASTERS.—There are few factories that keep wholly to this line of work. It is perhaps as simple as any part of the rubber business, a fair grade of rubber being washed, dried, and mixed by the usual methods, and calendered upon the fabric that forms the base of the plaster. These goods are not vulcanized, of course. Though a variety of gums and medicaments is used in this compounding, the range is probably smaller than any other line of rubber manufacture.

## II. THE WASHING, MIXING, AND CALENDERING OF RUBBER.

THE very first manufacturing process in the manipulation of rubber of any kind, and for any use, is that of the cleansing. This is usually done by passing the gum again and again between corrugated rolls, while fine streams of water remove the various impurities that are exposed by the tearing action of the rolls. These impurities are bits of vegetable substances, earth, sand, etc. The old type of washer for removing these was a couple of corrugated rolls 6 or 8 inches in diameter, and 12 or 14 inches in length. Modern methods, however, have introduced larger rolls, until to-day one machine, when it is the highest type of three-roll washer, will cleanse enough gum to keep a huge factory busy.

Some rubbers are so full of sand that it is almost impossible to remove it wholly. For this purpose is used a tub with a false bottom made of fine wire, and also with a stirrer. "Thimbles,"

for instance, after being run through the washer, are put in the tub without any attempt at sheeting, and stirred until a large portion of the sand is removed.

Another type of washer is one that is quite similar to a paper engine; in fact, paper engines are often used in rubber washing. The special value of this type is that the rubber in its movement about the tub is floated more or less, and the sand and earthy matters sink to the bottom, while the bark and vegetable matters can be seen and easily removed.

Some manufacturers, following Austin G. Day's ideas, have used alkaline solutions in washing certain gums, to neutralize the vegetable acids, and it is a question if it might not be as well to use dilute acids to neutralize the strongly alkaline qualities of gums that go through certain kinds of coagulation. Some factories also examine the coarser grades of gums chemically, and give them a treatment to remove odor. As a rule, however, manufacturers rush them through the washing machines, sheet and dry them, and get them into the mixing mills as soon as possible.

The drying of rubber, according to earlier practice, required a great deal of time. It was the boast of more than one rubber mill that no Para rubber was used by them until it had been dried for a year. The manufacturers of mechanical rubber goods were the first to break away from this tradition. In many cases they found, when there were rush orders on hand, that they must put on their mills gum that was practically just off the washer, and mix it, or else lose orders. Of course, they were forced to get most of the moisture out, or neutralize what was left, and they learned incidentally that they got a stronger compound with the green gum than with the "seasoned," whence the belief grew up that the months and years of drying were not necessary, as had before been supposed. In addition to this, some of them learned that long drying meant oxidation on the outside, or the turning of rubber into resin, which further increased their doubt of the wisdom of the slow drying process.

These thoughts once entertained, it was not long before various plans were introduced into the drying, for hastening the removal of the moisture. The simplest of these, of course, was



artificial heat, and the presence of a fan for removing the moisture laden atmosphere. Later developments have brought about a process for drying rubber very cheaply at quite a high heat, lasting only a few hours, that gives it to the man who runs the mixer, hot from the dryer, and that does away with the expensive process of breaking down. This latter idea is to some, of course, as revolutionary as was the first thought of quick drying, but that it is wholly in the line of progress, is proved by the fact that it has now been used for a number of years in many whose goods stand very high.

The milling of crude rubber is simply putting the dry rubber which is found in a tough, intractable sheet, on hot rolls, and running it until it gets to be a softened homogeneous mass. The gum, when this is accomplished, is ready for mixing. These mixing rolls are run at different speeds and are called friction rolls, and the various adulterants and ingredients that are to be incorporated with the rubber are pressed into a softened gum by their revolution.

No general rule can be laid down for mixing in all lines. An expert compounder knows that certain gums should be mixed on cool rolls, and others under considerable heat. His knowledge of specific compounds teaches him to hasten mixing in many cases where another, without skill, would require very much more time to get the same result. In some cases the ingredients are put in together, in others it is necessary one is put in last. Some have dissolved substances that would make the rubber stick to the rolls like glue unless they be put in at just the right time; others have so large a proportion of earthy matters that, unless the gum be humored, it apparently will not take them in, and so on. Each line of work and, in fact, each factory has its own special methods, and often one or more skilled mixers who can handle compounds that none of the others seem to be able to do anything with.

The use of the calender is simply to sheet the goods so that they may be easily made into the desired forms. The simplest form of calender is a mixing mill with the key that normally holds one roll in place withdrawn, so that both run by even



motion, which is used in many small factories where nothing but molded work is made.

The modern sheeting calender is ordinarily a three-roll machine. It is sometimes made with four rolls, however, and these rolls may be almost any size, the widest for rubber work being more than 80 inches. No little skill is required for running the calender on a variety of stocks, nor can any general rules be laid down for calender work. This is proved by the value that is set upon good calender men, and by the difference that there is between the work of a good one and a poor one. There are as many different kinds of calenders as there are patterns of mixing mills. A sheet calender has smooth rolls, and is for running absolutely smooth goods. In shoe work there are engraved rolls, pebbled rolls, and soleing calenders engraved in the likeness of the shoe sole. The carriage drill business has embossing calenders, and so on. A type of calender that is useful in most lines of work is known as the friction calender, the rolls in which, run at uneven speeds, drive the gum deeply into the fabric.

Where India-rubber is handled in solution there is used in place of the calender a spreading machine, known under various names of "Yankee flyer," "English spreader," "Doughing machine," etc. In this a sheet of rubber is spread on the cloth by being placed on an endless apron of the fabric, the apron running over the roll against which hangs a heavy knife. A very thin coating of the rubber solution is constantly scraped off this surface, which then passes over hot drums or steam chests, evaporating the solvent.

## CHAPTER IV.

### VULCANIZING INGREDIENTS AND PROCESSES.

THE average rubber manufacturer is not interested in exactly what vulcanization is—that is, what it is chemically. It is sufficient for him that India-rubber mixed with sulphur and heated results in a new compound, vulcanized rubber. It is, to be sure, interesting for him to know how much sulphur is combined and how much uncombined, and the effect that high temperatures, time, and pressures have upon resultant compounds. Nearly all of these problems, however, are individual to his own work, and are solved by him along practical lines. Considering compounded India-rubber as a dough which is fashioned into shape and baked, is about as far as the manipulator of rubber goes.

The means for vulcanizing India-rubber in general use are roughly two: the heat cure and the cold cure. Considering the first, a great variety of goods is cured in open steam heat and is kept in shape during vulcanization, either in molds or by being wound with strips of cloth or buried in pans of French talc. This is the wet heat and such goods are cured in vulcanizers, big and little, of which there are scores of types. A different application of heat is what is known as dry heat, where goods are put in a hot room without wrapping or mold protection, and left until vulcanization is effected. Another heat cure which at one time was very largely used, but to-day has practically disappeared, was what was known as solarization. This consisted in exposing fabrics coated with a thin skim of rubber to the rays of the sun, which effected a surface cure.

What is known as the cold cure has been practiced since the days of Goodyear, and within the last ten years has been much resorted to in the manufacture of certain lines of goods. This, in turn, divides itself into two methods—the acid and the vapor cure. In the former one-half pound of chloride of sulphur is mixed with four pounds of bisulphide of carbon. The

goods are dipped in this solution and afterwards treated with an alkaline wash. The vapor cure is where the fumes of chloride of sulphur are set free in a heated room or cabinet in which the rubber goods are hung so that all of the surface is affected. When the cure is far enough advanced the further action of the chloride of sulphur fumes is stopped by ammonia fumes.

While Charles Goodyear's patents for the vulcanization of India-rubber by the use of sulphur and heat were in force, a marvelous amount of ingenuity was shown in the attempts to accomplish the same results by the substitution of other ingredients for sulphur, either with or without the use of heat. These experiments and inventions embrace vulcanization, by means of chlorides, nitrates, nitrites, fluorides, bromides, iodides, and phosphorets of about all the common earths and metals, and also many gases such as sulphurous acid gas. The majority of these experiments have been lost sight of, partly because the Goodyear process is now open to the world, and partly because, for the majority of goods, the sulphur and heat cure is not only the cheapest, but the easiest to accomplish. It may be well, however, to review and record the experiments in this line, as there is no doubt that for special lines in rubber manufacture many of them have a suggestive value to-day.

One of the very first ingredients to which inventors and experimenters turned their attention was zinc. The veteran rubber manufacturer Jonathan Trotter described a process for preparing a vulcanizing material which he called hyposulphite of zinc. It was made from a solution of caustic potash saturated with flowers of sulphur and then treated with sulphurous acid gas. This solution he mixed with a saturated solution of nitrate of zinc, forming the precipitate that he desired. He used 3 pounds of hyposulphite to 10 pounds of rubber, curing from 3 to 5 hours, at 260° to 280° F.

Another American, E. E. Marcy, some years later patented a compound of hyposulphite of zinc and rubber which is apparently almost identical with Trotter's discovery, although he disclaimed similarity, and also made public the

process, in which he used a combination of hyposulphite of zinc and sulphide of zinc, the compound being 2 pounds of rubber, 1 pound sulphide of zinc, 1 pound hyposulphite of zinc, and other ingredients as deemed necessary. These goods were of a beautiful white color, were said not to bloom, and did not need the sunning process then in use. At the same time they depended upon sulphur and heat for whatever vulcanizing was accomplished.

Another attempt to get a good substitute for sulphur was in the production of what is known as sulphite or hyposulphite of lead. James Thomas describes at length a compound in which he mixes hyposulphite of lead and artificial sulphide of lead in equal proportions, his compound being for vulcanization, 2 parts by weight of India-rubber and 1 part of the vulcanizing material.

Following this thought came E. E. Marcy again, who mixed sulphide of lead and carbonate of lead in the proportions of 2 parts of sulphide of lead, 1 part carbonate of lead, and 2 parts protoxide of lead in place of the carbonate.

Then Oscar Falke and Albert C. Richards brought out a compound consisting of 6 parts India-rubber, 2 parts sulphide of antimony, and  $\frac{1}{2}$  part sulphite of soda, curing at  $270^{\circ}$  to  $280^{\circ}$  F.

A. K. Eaton, in no uncertain terms, disclaimed vulcanization by the use of free sulphur, but claimed to be the first to use sulphide of manganese. He also gave a formula for making it, which was by mixing intimately 44 parts of peroxide of manganese with 32 parts of sulphur, and exposing the mixture to heat in a covered crucible. He vulcanized several hours, from  $250^{\circ}$  to  $310^{\circ}$  F.

George Dieffenbach claimed sulphite of alumina as an ingredient which, in connection with heat, would bring about vulcanization. He used this in a compound for a dental rubber, which had for its basis India-rubber, amber, linseed oil, sulphide of cadmium, oxide of tin, vermilion, and pulverized feldspar.

Charles T. Harris cured India-rubber by combining it with an artificial sulphide of bismuth, which he explained as

being the artificial tersulphide, or polysulphide of bismuth. He describes this as being a heavy black powder, and the compound which he advised for soft rubber was 100 parts India-rubber, 75 parts carbonate of lead, and  $12\frac{1}{2}$  parts polysulphide of bismuth, cured in a dry heat at  $245^{\circ}$  F. for  $1\frac{1}{2}$  hours.

Henry W. Joselyn discovered that shale combined by heat with sulphur formed a sulphide which could be used in curing rubber, and hastened to patent it.

Andreas Willman brought out a process for combining India-rubber with "anhydrous chlorides, sulphates of alkalies" and powdered coke or coal, and claimed that his best result came from chloride of ammonium and coke. His compound was made up of litharge, lampblack, and powdered coke, in connection with from 2 to 10 per cent. of his vulcanizing mixture.

Edwin L. Simpson formed a vulcanizing compound by mixing benzoin gum with pulverized sulphur, and boiling it in linseed oil. It was used in a dry heat, the compound being 1 pound of India-rubber, 2 ounces vulcanizing compound, 8 ounces litharge, and 8 ounces whiting.

J. A. Newbrough manufactured a vulcanizing material which he called acid resin, made of turpentine and sulphuric acid. This he incorporated in India-rubber in the proportion of 6 ounces of acid resin to 1 pound of India-rubber, and cured at  $300^{\circ}$  to  $320^{\circ}$  F.

The use of selenium as a curing agent was discovered by E. E. Marcy, while connected with Horace H. Day, then prominent as a rubber manufacturer. He advised the use of equal parts of India-rubber and powdered selenium, and, to produce a glossy finish, he added selenium carbonate and whiting.

At the same time there were many other inventors who were experimenting with processes that were somewhat in the line of the well-known Parkes cold-curing process. For example, it is a matter of history that the late Joseph Banigan, early in his career as a rubber manufacturer, cured wringer rolls by an acid process.



Dubois C. Parmelee invented a process which he called "hermizing," to distinguish it from curing or vulcanizing, instead of the Parkes process, in which the solution of chloride of sulphur and bisulphide of carbon was used. He recommended briefly a solution as follows: 10 pounds of coal-tar naphtha, in which was dissolved 1 pound of sulphur. Into this solution he passed dry chlorine gas until it assumed a fine yellowish-green color. This solution he used as a dip for such goods as would be cured by the acid treatment. Parmelee also claimed the discovery of a solution made of coal-tar naphtha, bisulphide of carbon, and a solution of sulphur in bromine, mixed with this.

H. A. Ayling patented a cold curing process in which carbon spirits, one of the petroleum series, was mixed with chloride of sulphur, instead of the usual bisulphide of carbon.

Referring again to the suggestions of chlorine in the working of rubber, R. F. H. Havermann reduced India-rubber to a solution and subjected it to the action of chlorine. He also, in a later patent, described the washing of the chlorine out of the rubber by alcohol, and the addition of ammonia and lime, the result being, according to his specifications, a white hard rubber.

Working in the same line, John Helm, Jr., dissolved India-rubber in benzine and mixed it with liquid chlorine in the proportion of 12 ounces of chlorine to 1 pound of gum. His claim was that he could get rubber of any color and of any degree of hardness by this process.

In the line of hard rubber manipulation and vulcanization, L. Otto P. Meyer (then connected with the India-Rubber Comb Co.) patented a process for curing vulcanite in a vessel wholly or partly filled with water, the water in which the rubber was contained being in a tight receptacle, and the heat being raised above 300° F., the pressure of the surrounding steam keeping it from vulcanizing. This obviated the danger of burning, and was of great value in the production of certain goods.

While these and other inventors were trying to cure rubber without sulphur, and without interference with the

Goodyear patents, certain others were at work on other gums. For example, John Rider, who was at the head of a Gutta-percha company, produced what he called mettallothyanized Gutta-percha. In this, he first heated the Gutta-percha, then mixed 3 pounds of hyposulphite of lead and zinc with 8 pounds of gum, and sometimes added also a little Paris white, or magnesia. He then put the compound from 2 to 10 hours in a dry heat and cured it at 280° to 320° F.

John Murphy changed this compound somewhat, by advising the incorporation of sulphur in the proportion of 2 to 6 ounces of sulphur to 10 pounds of Gutta-percha. This sulphur, by the way, obviated the preliminary heating of the Gutta-percha, which was supposed to volatilize the ingredients that had before rendered it unvulcanizable.

A curious process for the manufacture of hard rubber was also brought out by William Mullee. In this, just as soon as the rubber was washed, the sheets were immersed in the sulphur bath, heated to 220° F. The water and other impurities in the rubber were said to be extracted by the action of the heated sulphur. After boiling 30 minutes, the sheets were removed with tongs and washed to prevent crystallization. They were then subjected to the same process a second time. The rubber was then compounded in the old fashioned way, on rolls, the proportions being 17 to 24 ounces of sulphur to 16 ounces of rubber. The claim for this was that the compound when cured was tougher than any others ever known.

William Elmer prepared what he called "elastic selenide of Caoutchouc." He first dissolved the India-rubber in bisulphide of carbon, placed it under pressure, and heated gradually. When brought to about 300° F., the liquefied selenium was put into the apparatus drop by drop, the solution in the meantime being kept in constant motion. This elastic selenide he claimed to be semi-fluid which, when evaporated, possessed all the characteristics of India-rubber.

The Parkes cold-curing process is so widely known as to require but a word. It is based on the invention of Alexander Parkes, and depends upon the faculty that chloride of sulphur has for vulcanizing India-rubber. (See Chloride of Sulphur.)

A curious process, similar to that of Parkes, is Caulbry's process, by which it is claimed rubber can be vulcanized at ordinary temperatures, by using an intimate mixture of chloride of sulphur and dry chloride of lime. During this mixture, and when the smell of the chloride of sulphur will be noticed, the temperature of the mixture will rise, the mass becoming plastic by the softening of the sulphur. If a mixture of this kind, in which sulphur is in great excess, be added to the solution of India-rubber in bisulphide of carbon, the rubber will be vulcanized at an ordinary temperature, or perhaps with a slight warming. Chloride of sulphur used pure is too corrosive in its effect on India-rubber; it is therefore reduced in all cases. Only thin articles can be vulcanized in this way.

A patent taken out in England by Edmond Garnier relates to the vulcanization of India-rubber by the use of alum. Previously alum processes for curing had not been very successful, but this patent had some novel features. It called for particularly dry alum treated with a solution of terebinth of benzol and shellac, or some similar gum. In use he took 8 ounces of alum and a solution composed of 1 part gum and 20 parts benzol. He mixed the ingredients that are usually employed in the manufacture of rubber, specifying 3 pounds of whiting, 1 pound barytes, 8 ounces lime,  $1\frac{1}{2}$  pounds oxidized oil, and 8 ounces of India-rubber. When these had been thoroughly mixed together and specially treated, alum was incorporated with them and well compounded, being passed through the mixing rollers cold. It was then calendered.

AMORPHOUS SULPHUR.—The fusing of 1 pound of sulphur with 4 ounces of Canada balsam produces what is known as Amorphous Sulphur, which is said to cure rubber so that it will have no tendency to bloom. The preparation has a very pungent sulphurous odor. Patented by Dr. Wilhoft, of New York.

ARTIFICIAL SULPHURET OF LEAD.—There are several combinations of lead and sulphur which may be produced artificially. That one containing the most sulphur has a composition of 13 per cent. of sulphur and 86 per cent. of lead. Its specific gravity is about 9.4. In color it is black. It melts at a strong red heat.

The other sulphur compounds of lead have much less sulphur, one containing but 9 per cent. and the other only 4 per cent. What is known as hyposulphite of lead is a mechanical mixture of the above first named, with a suitable percentage of sulphur to effect vulcanization. It is also known in the rubber trade as "Eureka compound" and "Burnt hypo." These compounds when pure—that is, when free from adulteration—are of great value. They produce goods that are jet black and have little odor and are free from bloom. They are reckoned as the safest vulcanizing agents, as it is almost impossible to burn goods that depend upon their presence for cure. They are used in either dry or wet heats.

BARIUM SULPHIDE is prepared from heavy spar by making a dough of it with charcoal and oil and subjecting it to a white heat. Sulphides of the alkaline metals, potassium, sodium, calcium, and barium, will vulcanize rubber, whence the term "alkalized rubber."

BROMINE.—A heavy deep red volatile liquid, possessing a most peculiar and unpleasant odor, and giving off vapors most irritating to the air passages and lungs. Its very name means stench. It has a powerful action upon most organic bodies, coloring animal matter brown, while it bleaches coloring matters, dyes, etc. Its specific gravity is 3.18. A piece of sheet rubber dipped into bromine is vulcanized instantly. It is somewhat soluble in alcohol, and very soluble in ether, bisulphide of carbon, chloroform, etc. Newbrough and Fagan filed two patents in the United States for the use of bromine in vulcanization, both with and without iodine. By adding to iodine  $\frac{1}{2}$  its weight of bromine, proto-bromide of iodine is formed, which is said to combine with India-rubber and produce a hard compound on being exposed 1 hour to a temperature of 250° F. To prevent the forming of an explosive the iodine and bromine were separately treated with oil of turpentine to which had been added a quarter of its weight of sulphuric acid. It was then mixed with the gum in the proportion of 2 pounds 11 ounces to every pound of gum. Bromine was also used alone by these inventors, the material after molding being plunged into the liquid, and left there long enough to harden. To prevent the hardening of the material while in the bath, chloroform or any other solvent of rubber was added in the



proportion of 1 part to 9 parts of bromine; in other words, the rubber vulcanized in the air after its withdrawal from the liquid.

CHLORIDE OF SULPHUR.—Sulphur and chlorine form three compounds, the monochloride, the dichloride, and a tetrachloride of sulphur. The substance usually used in the arts is the first named or a mixture of the first two. It is an oily liquid of the specific gravity 1.7, and boiling at 239° F. It has a pungent smell and decomposes on contact with water or watery vapor. Pure chloride of sulphur is of an orange yellow color of great density. It fumes strongly when exposed to air, throws off the vapors of hydrochlorine, and is quite poisonous, severely attacking the mucous membranes. It is widely known as the active agent in Parkes's cold-curing process, where it is used in connection with bisulphide of carbon. A common formula for this is chloride of sulphur, 1 part by weight, bisulphide of carbon, 30 to 40 parts by weight; immerse from 60 to 80 seconds. In the manufacture of balloons and toy balls, the solution is a far weaker one. That for the outside dip is 10 parts of chloride of sulphur to 100 parts bisulphide of carbon, while for the inside it is 16 parts chloride of sulphur to 100 parts bisulphide of carbon. When it was common to cure proofed cloth by the cold process, it was done by wetting its surface with a mixture of 5 to 10 parts of chloride of sulphur, dissolved in 100 parts of bisulphide of carbon, then running the fabric over heated drums to evaporate the mixture. In the sulphurization of oils for rubber substitutes chloride of sulphur plays a most important part, nearly all of the amber and white products being produced by its use. It also has a curious effect upon bastard gums, giving some of them temporarily the elasticity and appearance of high grade rubber.

GOLD BRIMSTONE.—See Sulphur.

GOLDEN SULPHURET OF ANTIMONY.—This is prepared from black antimony by boiling it with caustic soda and sulphur for some time. The liquid is then clarified by filtration or settling and the clear part treated with a dilute acid, preferably muriatic or sulphuric. A golden yellow precipitate is formed which should be well washed in water, and dried at not too high a temperature in a darkish place. The results of this operation well carried out are constant and the composition should be: Antimony, 60.4; sul-



phur, 39.6. Golden sulphuret of antimony heated in a tube will give off sulphur which will deposit on the cool sides of the tube away from the flame and the residue will turn black, being indeed the black sulphide of antimony. All samples of this compound should be tested for free acid, by shaking up a little of the powder in a test tube with cold or hot water, and testing the water afterwards with some barium chloride and blue litmus paper. A white cloud in the first place and the reddening of the paper in the second place indicate the presence of more or less free sulphuric acid. Golden sulphuret prepared with muriatic acid will not respond to the first test, but will to the second.

GOLDEN SULPHURET or ANTIMONY RED (pentasulphide) is used more largely than any other form of antimony in rubber work. It is frequently adulterated, sometimes with carbonate of lime, oxide of iron, or oxide of antimony, all of which tend to harden the rubber. Also called Orange Sulphide of Antimony. Properly used, this ingredient produces some of the best effects found in vulcanized rubber, in color, texture, and durability. It should never be mixed on a very hot mill, should be sheeted and placed in cooling racks if it is not to go right to the calender, and should be cured in as low a heat as possible. The ideal result will be of a golden yellow color, with a very slight bloom, if any. It is used only in high cost goods.

HONEYCOMB SULPHUR.—A vulcanizing compound made by boiling a pound of sulphur and two ounces of benzoin gum together, 1 pound of this material being mixed with a quart of boiled linseed oil.

HYPOSULPHITE OF LEAD.—See Artificial Sulphuret of Lead.

IODINE is manufactured from seaweed and is a black-gray substance occurring in small shining scales. Its specific gravity is 4.94 and it fuses at 239° F., giving off violet vapors. It is readily soluble in alcohol, benzol, chloroform, and sulphide of carbon. In addition to the formula given under the head of bromine, Newbrough and Fagan patented the combination of iodine and sulphur. In this the sulphur was boiled in turpentine, and the oil decomposed and deposited with the sulphur at the bottom of the vessel was used in the operation, after being washed in dilute sulphuric acid and dried. The iodine was

treated in the same manner to prevent explosions. Equal proportions of the two were melted together and incorporated in the proportion of 2 ounces 5 drams to 1 pound of rubber. After shaping, the articles were put in a vulcanizer and during the first fifteen minutes exposed to a dry heat, gradually increasing to 320° F., remaining there 5 minutes, then dropping rapidly to 250° F., and continuing for an hour.

**LIQUID CHLORINE.**—Chlorine is a greenish yellow gas at all ordinary temperatures. It has strong bleaching properties and also a very bad smell and action upon the respiratory passages. Under a pressure of 127 pounds to the square inch at 60° F., chlorine condenses to a yellow liquid, having the specific gravity of 1.33. Chlorine cannot, as a rule, destroy mineral colors or blacks produced by carbon. Helm claimed that he was able to produce white hard rubber by incorporating chlorine with the mass.

**LIVER OF SULPHUR.**—This is really penta sulphide of potassium, and is obtained by mixing carbonate of potassium together with sulphur. It is called Liver of Sulphur on account of its brown color. As it is quite volatile it should be kept in well closed glass vessels. The fluid for vulcanizing purposes is a concentrated solution of the penta sulphide, about 25° Baume being right for use. To cure with it the liquid is brought to the boiling point in a porcelain vessel, the articles to be vulcanized being immersed in it. This is known as Gerard's process and is said to be inexpensive and perfectly safe.

**MILK OF SULPHUR.**—Another name for what is ordinarily termed precipitated sulphur. It is fine, light, and grayish white in color, but is often adulterated with sulphate of lime. It should be kept in a dry place, as it has an affinity for moisture.

**NANTUSI** is a vulcanizing agent and preservative for rubber, manufactured under a secret formula, and in use in England. It is offered as preventing the superficial cracking of rubber exposed to the atmosphere; preserving the quality of the rubber; doing away with the possibility of acidification in sulphur as ordinarily used; and reducing the cost of the mixing. It is said to be a special mixture of paraffine and sulphur.

**PENTA SULPHIDE OF ANTIMONY.**—The chemical name for Golden Sulphuret of Antimony (which see).

PROTO-CHLORIDE OF SULPHUR.—See Chloride of Sulphur.

SULPHIDE OF LEAD.—Occurs native as galena and is one of the ores of lead, having a specific gravity of 7.2 to 7.7. Commercially it is found as a black powder, of specific gravity 6.9. Its composition is 86.6 per cent. of lead and 36.4 per cent. of sulphur. Sulphide of Lead is a very useful black pigment, and one that is used quite largely in rubber works, as it is a good filler and assists in vulcanization. It is often made from pure white lead by very simple treatment. It materially assists the resiliency of Para compounds.

SULPHUR LOTUM.—A name for sublimed sulphur that has been washed to remove sulphurous acids, and carefully dried.

SULPHIDE OF ZINC.—Sulphur forms with zinc two sulphides. One of these, the monosulphide, corresponds to zinc blende, which, as found native, is of various colors, from yellow to black. Its specific gravity is from 3.5 to 4.2. The other is a penta sulphide artificially prepared and occurs in the form of a white powder. Upon ignition in the absence of air this latter substance loses four-fifths of its sulphur, but the temperature at which this takes place is too high to render it available as a source of sulphur of vulcanization in compounding rubber mixtures. With a slight addition of sulphur it is used in the production of white goods.

SULPHUR occurs in a number of different forms, and under various names as brimstone, flowers or flour of sulphur, roll sulphur, rock sulphur, etc. Its specific gravity is 1.98 to 2.06. It melts at 239° F., thickens and becomes orange yellow at 320° F., at 428° it is semi-solid and red, and on carrying the heat higher it becomes browner and boils at 788° F. Some of the sulphur now used commercially is recovered from alkali waste, but most of it comes from Sicily, where it is found native. It is more generally used in rubber works than any other ingredient, and in all proportions from 3 per cent. up to 100 per cent. of the weight of the rubber. The ordinary form in which it is found in the rubber factory is in a yellow powder, known as flowers of sulphur. It has a slight affinity for moisture, and careful manufacturers keep it covered from air to avoid the formation of sulphurous or sulphuric acids. Mixed with certain oils by heat, it forms the black sulphur substitutes that are often used in rubber

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compounding. Sulphur in the form of rolled brimstone is pulverized, sifted, and used in the place of flowers of sulphur, in France, and is equally good and cheaper.

SULPHUR BALSAM.—A solution of sulphur in fixed oils, consisting of 2 ounces of flowers of sulphur in 8 ounces of linseed oil, used in proofing compounds.

VESUVIAN WHITE.—A special vulcanizing material manufactured in England, for use in the manufacture of tennis balls and other goods.

VULCANINE.—An English vulcanizing preparation, used for both steam and dry heat goods. It occurs either as a white or a black powder, depending upon the line of goods on which it is to be used.

VULCOLE.—A paste furnished in two colors, white and black, that, added to certain compounds, prevents blooming. It also has the quality of rendering flowers of sulphur inert if used in excess, so that 50 to 75 per cent. can be used in an ordinary soft compound.

Garnier, in an English patent, mixes rubber cold (?) with shellac dissolved in benzole and adds alum, claiming that the product is similar to vulcanized rubber.

Raymond, in another English patent, uses for vulcanizing a mixture of benzine, camphor, chloride of sulphur, and oleic acid.

The table on the following page indicates vulcanizing pressure in pounds per square inch in gage, and temperatures by the Fahrenheit scale:

## VULCANIZED PRESSURES AND TEMPERATURES.

Pressure in lbs. per sq. inch in gage.	Temperature in Fahren- heit degrees.	Pressure in lbs. per sq. inch in gage.	Temperature in Fahren- heit degrees.	Pressure in lbs. per sq. inch in gage.	Temperature in Fahren- heit degrees.
7	232.3	39	285.4	71	316.7
8	234.7	40	286.6	72	317.5
9	237.1	41	287.8	73	318.3
10	239.4	42	288.9	74	319.1
11	241.6	43	290.1	75	319.9
12	243.7	44	291.2	76	320.7
13	245.8	45	292.3	77	321.4
14	247.8	46	293.4	78	322.2
15	249.7	47	294.4	79	323.0
16	251.6	48	295.5	80	323.8
17	253.5	49	296.5	81	324.5
18	255.3	50	297.5	82	325.2
19	257.0	51	298.6	83	326.0
20	258.7	52	299.6	84	326.7
21	260.4	53	300.6	85	327.4
22	262.0	54	301.5	86	328.1
23	263.6	55	302.5	87	328.9
24	265.2	56	303.5	88	329.6
25	266.7	57	304.4	89	330.3
26	268.2	58	305.3	90	331.0
27	269.7	59	306.3	91	331.7
28	271.1	60	307.2	92	332.3
29	272.6	61	308.1	93	333.0
30	273.9	62	309.0	94	333.7
31	275.3	63	309.9	95	334.4
32	276.7	64	310.8	96	335.1
33	278.0	65	311.6	97	335.7
34	279.3	66	312.5	98	336.4
35	280.5	67	313.3	99	337.0
36	281.8	68	314.2	100	337.7
37	283.0	69	315.0		
38	284.2	70	315.8		



## CHAPTER V.

### FILLERS AND OTHER INGREDIENTS USED IN DRY MIXING RUBBER COMPOUNDS.

INDIA-RUBBER is compounded for two reasons, the first being to reduce the cost without destroying the usefulness of the gum, the second being to impart to the gum qualities possessed by a great variety of mineral, vegetable, and even animal substances. Each of the ingredients treated in this chapter has some specific use. While their arrangement may seem a little incoherent to the chemist, it will be fully appreciated and understood by the rubber manufacturer whose habit of mind leads him to reach out into any of the kingdoms—animal, vegetable, or mineral—for assistants in compounding problems.

ACETATE OF LEAD.—A white, sweetish-tasting powder soluble in water and alcohol. In its crystalline form it contains about 7 per cent. of water of crystallization, which is easily driven off at a temperature of, say, 80° to 100° F. Its specific gravity is: crystallized, 2.3; water free, 2.5. Its use in semi-hard composition was patented by both Goodyear and Payen. India-rubber dissolved in oil, to which has been added acetate of lead, is used to fill the pores of certain leathers so that the "filling" shall not come through. It is also used in certain varnishes in connection with Gutta-percha.

AGALMATOLITE.—A silicate of aluminum resembling soapstone which is soft enough to be carved with a knife. It has no advantages over talc, silicate of magnesia, or soapstone in rubber use. The largest deposits of this material are to be found in China.

ALUMINUM FLAKE.—A curious natural product in the form of a white powder, free from grit, with a specific gravity of 2.58. It is a remarkable heat resistant, is inert in compounds, and toughens them. Is used instead of zinc oxide, both for color and strength. Is largely used in rubber work in the United States and Canada.

ALUMINITE.—A white clay containing a large percentage of aluminum (about 30 per cent.) and a certain amount of silica. Its

specific gravity is low, and its fusing point 2,400° F. Found in the United States.

**ALUMINA.**—The oxide of aluminum and a chief constituent of clay. Its specific gravity is 4.154. Ordinarily speaking, it is a very inert substance, insoluble, and not readily attacked by acids. It is best known in the arts under the forms of corundum, emery, etc. As obtained chemically it is a fine white glistening powder, feeling harsh and dry to the touch. Eaton's formula for the use of oxide of aluminum in making a pure white rubber was: India-rubber 40 per cent., oxide of aluminum 55 per cent. and sulphur 5 per cent.

**ALUNDUM.**—A patented abrasive material made from oxide of aluminum or bauxite.

**AMPHIBOLINE.**—A German earth. When wetted and dried, it will not absorb water again. Used in waterproofing, the product being non-inflammable. Is mixed with gelatine or size, no rubber being used: 34 parts amphiboline, 9 parts gelatine, 2 parts chrome alum, 2 parts ammonium sulphate, 53 parts water.

**ANHYDRITE.**—The water-free mineral form of sulphate of lime or gypsum. It has a specific gravity of 2.9, and is formed artificially by heating gypsum so as to drive off all its water. It is white in color and crystalline in form. Gypsum that has been overheated in the preparation of plaster of paris and that has lost its ability to "set" is pure Anhydrite. It is used as a filler in rubber compounding instead of whiting or paris white.

**ANTIMONY.**—See Golden Sulphuret of Antimony, Black Antimony, and Kermes.

**ARGILLACEOUS RED SHALE.**—A shale that has a large amount of clay in it is termed Argillaceous, and the substance mentioned in the heading may be briefly termed clay tintured red with oxide of iron. The analysis of Argillaceous clay shows: Alumina 39, silica 46, water 13, iron, magnesia, and lime 2. It was the basis of a well-known oil-resisting compound that for years baffled imitation.

**ARTIFICIAL SULPHURET OF LEAD.**—See Burnt Hypo.

**ARSENIC.**—A white, brittle metal, with a specific gravity of 4.7 or 3.7, according to its form. Also a popular term for the oxide of arsenic sometimes called the white arsenic, which is a

heavy white powder of the specific gravity 3.7. White arsenic, arsenious oxide, is slightly soluble in cold water and to the extent of 10 per cent. in hot water. There are several coloring matters formed from arsenic, all of which are to be condemned for general use. The most familiar are paris green; realgar, which is red, and orpiment, which is yellow. The white oxide is rarely used in rubber work, and is to be avoided, as are the greens, reds, and yellows. The green has been used in mechanical rubber goods, but the color was not a valuable one. Hancock vulcanized Gutta-percha with orpiment, and Forster used it in "mosaic work" for floor coverings. An anti-fouling composition for ships' bottoms is formed of Gutta-percha, copper, bronze, and arsenic. Another is formed of: India-rubber 2 pounds, rosin 7 pounds and arsenic 2 ounces.

ASBESTIC.—The part of the rock remaining after the richer veins of asbestos have been extracted. This remainder is a purely fibrous material, clearly showing its origin. For mechanical uses it is ground fine, and for all sorts of fire-proofing purposes is valuable and much cheaper than long fiber asbestos. It is mined at Danville, Lower Canada. It makes an excellent compounding material for asbestos packings, etc., in connection with rubber.

ASBESTINE.—A pure fibrous silicate of magnesia, called also mineral pulp. It is mined near Gouverneur, New York, where is the only deposit at present known where magnesia shows so distinct a fiber. It is very largely used in the manufacture of paper, and also as an ingredient in rubber. Apparently the pulverized mineral is a very strong white powder, but in actual use it has not much more covering quality than whiting. It was at one time used largely in the manufacture of rubber shoes, but, aside from being inert and a good filler, was probably no better than whiting, while it was more costly. It is often used in white goods, in connection with oxide of zinc, to make a light weight compound. It is also known as agalite and asbestine pulp. Its composition is: Silica 62, magnesia 33, water 4, iron oxide and alumina 1.

ASBESTOS (*Amianthus*).—A fibrous silicate of calcium and magnesia, also called stone flax, salamander's wool (from an

old belief that it was originally made from the wool of the salamander), cotton stone, mountain flax, mountain wood, and mountain cork. Its specific gravity is 3.02 to 3.1. An analysis of the two best known varieties shows:

	Canadian.	Italian.
Silica .....	40.92	40.25
Magnesia .....	33.21	40.18
Water of hydration .....	12.22	14.02
Alumina .....	6.69	2.82
Protoxide of iron .....	5.77	.75
Soda .....	.68	1.37
Potash, etc. ....	.22	.15
Sulphuric acid .....	traces	.31

The longest fiber is possessed by the Italian, which is sometimes 3 feet in length. The Canadian ranges from 3 to 6 inches in length, but it is finer, more flexible, and more easily separated than the Italian. The mineral divides itself naturally into three classes: the first, coarse, brittle, very plentiful, and cheap; the second, possessing well-defined fibers of a brownish-yellow color, fragile, and containing many foreign bodies; the third, with pure white silky fibers which can be woven into textiles. A notable use to which asbestos has been put in the United States is in the production of the packing known as Vulcabeston (which see). Its low conductivity of heat renders it particularly useful in steam packings, both for cylinder work and for joints, while its incombustibility has long caused it to be used for fireproof purposes. There are fibers formed of serpentine rock which are much used as a substitute for genuine asbestos, and answers nearly as well, being, however, shorter in fiber and somewhat less durable. Almost all large rubber manufacturers produce packings in which there is a certain amount of asbestos, often assisted by infusorial earth, asbestine, etc.

ATMID.—A very light white earthy matter, marketed by an English corporation. Analysis proves it to be an almost pure silica—quite close, in fact, to infusorial earth.

ATMIDO.—A snow-white filler of low specific gravity, free from organic matter and indifferent to acids. Used in small proportions, is said to increase both strength and resiliency in



soft rubber goods. Used in large proportions, it makes a very hard compound, said to resist superheated steam. Manufactured in Germany.

BARYTES.—A heavy white mineral that in commerce takes the form of a fine white or gray powder. It is obtained by grinding the mineral heavy spar, or by chemical means from baric chloride. Its specific gravity is 4.5. It occurs in commerce under the names "permanent white" and "blanc fixe." The artificially-prepared substance is to be preferred to the finely-ground mineral, on account of its less crystalline form. The commercial article should always be examined to determine its freedom from acid impurities. Barytes is chiefly used as an adulterant for white lead and paints. Thus, Venice white contains equal parts of sulphate of barytes and white lead; Hamburg white, 2 parts to 2 parts of white lead; and Dutch white, 3 parts to 1 part of white lead. It is wholly inert when used as an ingredient in rubber compounding, and increases the resiliency of rubber, and is a make-weight.

BLACK ANTIMONY.—A black powder obtained by grinding stibnite or antimony ore. It is a sulphide of the metal and is met with more or less pure, as it is often prepared from a high-grade ore. The sulphur contained in it is unavailable for vulcanizing purposes, and if used in compounding it is necessary to add a sufficiency of sulphur to vulcanize. In the purest form, black antimony contains about 28 per cent. of sulphur and 72 per cent. of antimony. It is insoluble in water, but is dissolved by muriatic acid or by caustic alkalies. From its solution in alkali a fine brown-red powder may be obtained by treatment with a dilute acid, and this powder, known as kermes, has the same chemical composition as that mentioned above. Its specific gravity is 4.6. It was formerly used sometimes as a filler, as it was believed to give a soft effect in molded goods. It has been almost wholly displaced, however, by cheaper and better ingredients.

BLACK HYPO.—See Hyposulphite of Lead.

BLACK LEAD.—See Plumbago.

BLUE LEAD.—Where zinc ores are found in combination with galena, or natural sulphide of lead, the two are often smelted



together with raw coal and slaked lime, producing a fume called blue powder, which is sold under the name of Blue Lead. It is an excellent filler, but is not as good as sublimed lead; for example, as it does not impart enough resiliency to rubber. Its chief merit is its cheapness. A very fine quality of Blue Lead, containing considerable lead oxide, is now on the market, but this must not be confused with either of the two low-grade articles mentioned in these paragraphs. This Blue Lead is of exceeding fineness, and gives a peculiarly soft finish to the rubber. Used in the place of litharge, it materially assists in the cure, and produces a fine black. As it has a high specific gravity, it often displaces barytes. Blue Lead is also a name given to an artificial aluminous substance occurring either as a loose powder or in a concrete form, colored blue by means of some kind of blue dye—*aniline* or *logwood*—which does not contain lead.

BONE ASH.—See Phosphate of Lime.

BONEBLACK.—See Animal Charcoal.

BUCARAMANGUINA.—A transparent amber-colored, incombustible material, found near Bucaramanga, Colombia. It is somewhat similar to asbestos, for which it has been mentioned as a substitute in the manufacture of packings.

BURNT UMBER.—An earth containing a large amount of iron oxide of a dark-brown rust color. As mined, it is called raw umber, and the product obtained by calcining it is known as Burnt UMBER. It is a fairly useful filler in compounding, as its action, or rather lack of action, upon rubber makes it safe to use. It is used in brown packings and, to a certain extent, in maroon goods.

CALAMINE.—An ore of the metal zinc, and a carbonate of zinc. Ordinary Calamine, which is a silicate of the metal, has a specific gravity of 3.6 to 4.4, and is little used in the arts. Noble Calamine, or native carbonate of zinc, is a gray or grayish yellow to brown powder, according to its priority. Its specific gravity is 3.4 to 4.4. Its nature is earthy, and heat has no action upon it. A little of it is said to toughen soft compounds.

CALCIUM WHITE.—Another name for Whiting.

**CALOMEL.**—A white, tasteless, and inodorous powder of specific gravity about 7.2. It is permanent in the air, but should be kept in the dark, as light blackens it. When pure, it may be wholly volatilized by heat, but if this cannot be done, then the sample tested contains other bodies. Calomel strikes a black color under the action of alkalies. It is insoluble in water, alcohol, ether, or benzine. It is the basis of a compound for rendering woven hose waterproof, the other ingredients being magnesia, black antimony, oxide of zinc, tar sulphur, and India-rubber. Its office is to hasten the cure.

**CARBONATE OF BARYTA.**—Known also as the mineral witherite; has a specific gravity of 4.3. It is a white powder insoluble in water and alcohol. (See Barytes.)

**CARBONATE OF LEAD.**—See White Lead.

**CARBONATE OF LIME.**—Very familiar under the native form of limestone, marble, or chalk. Specific gravity 2.7 and 2.9. (See Whiting.)

**CARBONACEOUS CLAY.**—Found near Lake Albert, South Australia. After being boiled at a high temperature with caustic soda and washed with a weak solution of sulphuric acid, it assumes a remarkably light, spongy, elastic character. It is used as an absorbent, and as a substitute for cork in linoleum, and is suggested as an ingredient for use in connection with rubber for playing-balls, etc.

**CARBURET OF IRON.**—A name given to a mixture of graphite and oxide of iron. A fine black-brown powder, fairly heavy specifically, although variable. It makes a fair filler in compounding, being inert and strongly coherent. In packings it has been largely used, and also in compounds for wagon covers and tarpaulins before reclaimed rubber came largely into use. It has also been used in cements for card clothing.

**CHALK.**—A white, soft, somewhat gritty substance, consisting chiefly of carbonate of lime. It is made up of myriads of very small shells of marine animals long extinct. Its nature is earthy; that is to say, it is not easily affected by ordinary bodies. Acids disengage carbonic acid gas from it. Its specific gravity is 2.9. If heated to a red heat, carbonic acid gas escapes and quicklime is left behind. (See Whiting.)

**CHARCOAL (ANIMAL).**—Animal Charcoal is made from calcined bones and has the property, in a high degree, of absorbing odors. It is often used, therefore, in deodorizing rubber goods, and experimentally by chemists for filtering Gutta-percha dissolved in bisulphide of carbon, where a perfectly clear product is desired. Its use is advised by Forster in Gutta-percha compounds, and by Warne, Jaques, and others for packings to withstand heat. (See Boneblack.)

**CHARCOAL (VEGETABLE).**—This is a popular term for the coal produced by the charring of wood. There are many materials which are really Charcoals, such as animal charcoal just quoted, carbon, coke, graphite, and wood Charcoal. All of these are practically the same in their pure states, being almost wholly carbon. Wood charcoal, which is what is meant in rubber compounding by vegetable Charcoal, consists of carbon, hydrogen, and oxygen, the last two being in the proportion to form water. As it retains the form of the wood from which it is made, it is powdered before use. It is black and brittle, insoluble in water, infusible, and non-volatile in the most intense heat. It has the power of condensing gases and destroying bad smells. Charcoal may or may not be a bad conductor of heat and a good conductor of electricity, these properties depending upon the wood from which it is made. Technically, it is divided into hard wood charcoal and soft wood charcoal. Its composition at ordinary temperatures is about as follows: Carbon 85 per cent., water 12 per cent., ash 3 per cent. It is used in rubber compounding in certain vulcanite varnishes and in certain insulated wire compounds. For this latter use, willow Charcoal is preferable, as it is a decided non-conductor. It has also been used in sponge rubber, with the idea that it acts as a preservative in a compound which is very likely to be short-lived. One curious use for it, a possible and valuable one, was in the attempted manufacture of cop tubes from Gutta-percha and Charcoal. Macintosh also used large quantities of ground charcoal in place of lampblack in some of his compounds. A French substitute for vulcanite paints or lacquers is made of 10 pounds of bitumen, 15 parts of Charcoal, and a little linseed oil, mixed by heating.

CHINA CLAY.—See Kaolin.

COMPO.—A name for a composition used in rubber manufacture in the United States years ago, but not in use now. The name, however, clings to two compounds sold by an English chemical house for use in rubber work. They are of a secret nature. No. 1 is used in the manufacture of oil-resisting valves and in tubing for chemical factories, in the proportion of 30 pounds of Compo to 10 pounds of rubber. No. 2 is used for soles for tennis shoes and in mechanical goods, in the proportion of 25 pounds of Compo to 10 pounds of rubber.

CORNWALL CLAY.—See Kaolin.

CORK, in granulated or powdered form, has long been a favorite ingredient in rubber compounding. Not that it is used in any such measure as whiting or barytes, but many mills have used it, and a few in large proportions. Used in connection with India-rubber and Gutta-percha, it has been the subject of some fifty patents. Its largest use, perhaps, was in the manufacture of Kamptulicon, where India-rubber is used as a binding material, and in linoleum, where oxidized oils are used in place of rubber. It was also used in what was known as leather rubber, in which palm oil distillate, a little India-rubber, and a good deal of granulated cork were used. At one time it was also compounded with rubber and made up into a waterproof felt for hats. It also went into compounds to resist heat, into cricket balls, and into golf balls, where it was compounded with Gutta-percha and enough metal filings added to give the necessary weight. A rubber blanket used in special manufacture also had its surface covered with granulated Cork as an absorbent material. In some cases the Cork was charred and roasted to remove what resinous matter might be in it, while in others resinous matter was removed by boiling in alcohol. As is generally known, Cork is the bark of the cork oak, a native of the south of Europe and north of Africa. The chief supplies come from Spain and Portugal. Cork is the basis of the fine black known as Spanish black, which is made by burning the refuse in close vessels.

CORUNDUM.—A mineral which is nearly pure alumina, yet of great specific gravity, and of exceeding hardness, being

inferior, in this respect, only to the diamond. Emery (which see), so largely used as a polishing substance, is a variety of Corundum.

DIATOMACEOUS EARTH.—See Infusorial Earth.

ELECTRIC FACING.—See Farina.

EMERY.—The average composition of Emery may be taken as alumina 82, oxide of iron 10, silica 6, lime  $1\frac{1}{2}$ . Its specific gravity is about 3.8 to 4. It is prepared by breaking the stone at first into lumps about the size of a hen's egg, then running it through stamps, and crushing it to powder. It is then sifted to various degrees of fineness, and graded according to the meshes of the sieve. Emery is next in hardness to diamond dust and crystalline corundum, and it is used chiefly as an abrading agent. Prior to the invention of vulcanite, emery wheels were made by mixing clay and emery in suitable mounds, and vitrifying them like common earthenware. In rubber mills it is chiefly used in the manufacture of what are known as vulcanite emery wheels. It is also used in grinding and sharpening compounds, as hones and strops. (See also Alumina and Corundum.) A certain amount of it also gives the desired surface to rubber blackboards.

FARINA.—This is sometimes used in small quantities in unusual mixtures as a compound, but has little value, as there are many better substitutes for it. A practical use for it, however, is the brushing of a rubber surface with it before vulcanization, when it is necessary to have printing or stamping done upon that surface afterwards. Farina is made largely of potatoes, another name for it being Potato Starch. The process consists simply of crushing, sifting, washing, bleaching, and grinding, which is repeated three times, and each time the starch granules separate and are collected. Potato Starch will be remembered by rubber manufacturers as the material which the gossamer makers used successfully for a number of years in the production of the "electric" or "corruscus" finish. Bone ash is used sometimes in the place of Farina, where rubber surfaces are to be printed upon.

FELDSPAR.—A name given to a group of silicates of which the principal ones are Orthoclase or potash, feldspar, containing silica, alumina, and potash, and having a specific gravity of 2.5; Albite, containing silica, alumina, and soda, specific gravity



2.61; Oligoclase, containing silica, alumina, soda, and lime, specific gravity 2.66; and Anorthite, containing silica, alumina, and lime, with a specific gravity of 2.75. The feldspars by the action of the weather break down into china clay, kaolin, or pottery clays. Ground very fine, they have been used in the production of rubber enamels and lacquers.

**FIRE CLAY.**—A kind of clay which, better than any other, resists the action of heat and direct flame. It is composed principally of silica and alumina, with traces of the alkali earths. The best is found in conjunction with coal, and is called Stourbridge clay. Its specific gravity is about 2.5, and its color dirty white. Mixed with vulcanized India-rubber, dissolved in tar oil and sulphur, it forms a compound which, when applied to hot joints, cures at once.

**FLINT** is practically pure silica and has the specific gravity of 2.63. The nature of the powder obtained by grinding is always sharp and gritty. It is unacted upon by all ordinary means, and with difficulty even in the laboratory of the chemist. Its principal use, perhaps, is in the manufacture of glass. Flint varies in color from yellow and brown to black. It has been used in erasive rubbers, although pumice stone is better.

**FLOUR OF GLASS.**—Glass powdered and sifted through a fine sieve of 150 meshes to the inch. Glass varies much in its composition, the more common kinds containing lime, while the so-called flint glass contains lead. Potash and soda also enter into the composition of glass; hence all flour of glass will contain those ingredients which entered into the composition of the glass it was obtained from. Generally speaking, Flour of Glass may be considered an inert substance under ordinary conditions, though the softer kinds are attacked even by boiling water. It was used by Newton and Wray in insulated wire compounds, and has also been used in certain packings.

**FLOUR OF PHOSPHATE.**—See Phosphate of Lime.

**FOSSIL FARINA**, also called mountain milk, is an earth physically similar to infusorial earth. It is obtained from China and consists of silica 50½, alumina 26½, magnesia 9, water and organic

matter 13, with traces of lime and oxide of iron. It has been used in rubber compounding for the production of packings and semi-hard valves.

**FOSSIL MEAL.**—A kind of earthy mineral, principally composed of the minute shells of very small animals long extinct. It is similar to infusorial earth, lime and silica entering chiefly into its composition. It is used for the same purposes as infusorial earth (which see) or silica.

**FRENCH CHALK.**—This is ground and sifted talc, forming a white, greasy-feeling powder. Its chemical composition is hydrated silicate of magnesia, the water being chemically combined. Its specific gravity is 2. (See Talc.)

**FULLER'S EARTH.**—A kind of clay. It is a greenish or brownish earthy, somewhat greasy-feeling, substance, having a shining streak when rubbed. Its composition is: Silica 70, oxide iron 2.5, alumina 3.5, lime 6, combined water 16, magnesia trace, phosphoric acid trace, salt 2, alkalies trace. Fuller's Earth is found in extensive deposits in England, where its annual consumption at one time exceeded 2,000 tons, chiefly in the woolen manufacture, for fulling cloth. Its specific gravity is from 1.8 to 2.2. It is used in rubber compounding for about the same purposes as infusorial earth, and is also used in the manufacture of rubber type.

**GRAPHITE.**—See Plumbago.

**GYP SUM.**—See Sulphate of Lime.

**INFUSORIAL EARTH.**—This is obtained usually from deposits at the bottom of inland waters, and consists of the minute siliceous remains of infusoria or microscopical animals. It is known also as fossil flour, mountain flour, and infusorial flour. The largest deposits, in the form of a fine white or pinkish powder, are found in Nova Scotia and in Germany. This earth is a wonderful non-conductor of heat, and, in connection with asbestos, is used in the manufacture of boiler coverings. It is used also in small proportions in various rubber compounds, where it increases both strength and resiliency, though if used in excess it makes a very hard compound. The best grades are wholly free from vegetable matter, are nearly pure silica, and perfectly indifferent to corrosive

substances. Under the name of diatomaceous silica it is used in a formula for elastic valve packing, patented by A. B. Jenkins, United States. This packing is described as practically indestructible in steam or water, oils, acids, etc. Specific gravity, 1.66 to 1.95.

IRON PYRITES.—A natural sulphuret of iron, commonly of a bright, brass-yellow color; a very plentiful mineral often mistaken for gold. It is used in the manufacture of sulphuric acid, while sulphur is also obtained from it by sublimation. It was used by Warne, Fanshaw, and others, in the manufacture of packings to resist a high degree of heat. The sulphur in Iron Pyrites has also been used in vulcanization. Warne, in one of his heat-resisting packings, patented the use of Iron Pyrites, and, in the compound that he gives as an example, leaves out the whole or a portion of the sulphur usually employed. (See Vulcanization.)

KAOLIN.—A white clay largely used in the manufacture of porcelain. It is a hydrated silicate of alumina.

KERMES.—A brownish red form of sulphide of antimony, artificially prepared by boiling in carbonate of soda. If left to itself the solution will partly deposit a very fine powder of Kermes, while the clear solution may be further treated with a weak acid to obtain the remainder. Kermes will not vulcanize rubber without the addition of sulphur. Its specific gravity is about 4.5. Its composition is 28 per cent. sulphur and 72 per cent. antimony. It is rarely used in rubber compounding.

LIME.—The oxide of the metal calcium. It is commonly known in two states, viz.: Quick Lime, which is the pure Oxide, and Slaked Lime, which is the hydrated oxide mixed with some carbonate. Quick Lime is a white solid substance of specific gravity 3.2. It is not stable, taking up water and carbonic acid from the air and breaking down into a fine white powder, usually called air-slaked lime. Its power of absorbing water has caused it to be favorably used in drying operations, while the insoluble compounds it forms with various oils have led to its being considered as a drier, although this action is not properly to be called one of drying. Lime, air-slaked, is used in rubber work, where

there may be a little moisture in a compound, which it readily neutralizes. It is also used in soft cements in connection with tallow and India-rubber, but only where the rubber has been melted and the cement is of the non-drying variety. In compositions like that of Sorel's, Lime is introduced to effect a combination between resin acids found in the resin and resin oil. Excess of Lime in India-rubber is injurious, because it renders the compound too open, thus inducing oxidation. When used in small quantities, aside from its effect upon moisture, it combines with free sulphur and modifies its continued action upon the rubber. It must be remembered, however, that lime diminishes the resiliency of India-rubber, while it increases the hardness of both hard and soft rubber. It may be used in small quantities in insulated wire, and in a measure assists the insulating capacity of the rubber. Calcium carbonate, in connection with colcothar and methyl alcohol, is used as a compound for cleansing vulcanite. Rubber also cures quicker when compounded with lime.

LITHARGE.—One of the oxides of the lead, known as the monoxide. When pure its specific gravity is 9.36. Commercial litharge often contains carbonic acid gas and water taken up from the air. These may be removed by strong heating. It has a peculiar property, the nature of which is yet a debated question, by virtue of which it renders oil more easily oxidized, or, as it is commonly called, rendered dry. There is no reason to suppose that this action is available with caoutchouc. The best Litharge is made from pig lead, which is placed in a reverberatory furnace and exposed to a current of air, which burns it to an oxide. It has been noted in rubber factories that certain men seem specially sensitive to the effects of Litharge, often developing serious symptoms of lead poisoning. Persons who show any symptoms should pay scrupulous attention to personal cleanliness. It is said that such persons have been cured by taking them out of the mixing room entirely, and putting them to work on vulcanizers, particularly where they open and handle the goods from the finished heat, the theory being that the sulphur fumes neutralize the effects of the lead. Possibly there is a grain of wisdom in this, for the



old fashioned treatment for lead poisoning was sulphur baths and the drinking of water aciduated with sulphuric acid or the acid of sulphate of magnesia. Litharge is not only a valuable filler for rubber, but has the faculty of hastening vulcanization in a marked degree. All dry heat goods depend upon it, and in mold work and general mechanical goods it is used whenever possible. Of course, it is generally available for dark or black effects only.

LITHOPHONE.—See Colors.

LITHARGRITE.—A substitute for litharge, made of a mixture of pulverized and calcined magnesia and oxide of lead.

MAGNESIA.—A white dry powder which, when mixed with water, forms a hard compact mass like marble. Its specific gravity is 3.65. It is earthy in its nature, having no taste, but producing a sense of dryness in the mouth owing to its absorption of the water therein. It is frequently called calcined magnesia from the method of preparation by burning magnesia alba. Its use in rubber is to increase its toughness and resiliency, which it does to a marked degree when used in moderation. Magnesia is also used in the production of compounds like balenite, its use in hard rubber compounds being to increase resiliency as well as hardness. A very small quantity of it is also used in compounds for insulated wire, where it is said to increase the insulating qualities of rubber. Carbonate of magnesia occurs native in the mineral magnesite and, in connection with carbonate of lime, as dolomite.

There exist two kinds of calcined Magnesia: the *heavy* and the *light* calcined. Heavy calcined Magnesia is produced by calcining heavy carbonate of Magnesia, which carbonate is won by precipitation of hot Magnesia solutions by hot solutions of soda. The light calcined Magnesia is produced by calcining the light carbonate of Magnesia, and this light carbonate is the precipitation product of Magnesia solution together with soda solutions, both carefully cooled. The difference between kinds of calcined Magnesia concerns only the structure, so that light calcined Magnesia in a dry state seems to have a very big volume, but if the air bladders are driven away and the pores of the material filled by introducing the light Magnesia into liquids, it is easily to be seen that the big volume cannot have the expected effect, if light



calcined Magnesia is kneaded together with India-rubber on the mixing rollers. The vulcanization of India-rubber can easily be accelerated by addition of calcined Magnesia. Such an addition is often necessary with soft rubbers in open steam cured compounds. Rubbers with a high amount of resins, such as Guayule, Cameroons, Assam, Borneo, etc., usually give better results if compounded with appropriate additions of calcined magnesia.

**MANGANESE.**—A metal of the iron group; gray or reddish white in color, and must be kept under rock oil or in well-sealed vessels, being easily destroyed by the air. Its specific gravity is 7.2. Manganese is obtained artificially as a black powder, by exposing the peroxide to prolonged heat. When ignited it is converted into red oxide, which corresponds to the black oxide of iron. The black oxide of Manganese of commerce is the peroxide. Oxides of Manganese have a destructive effect on rubber and blacks that contain this, as they sometimes do, are to be avoided. Manganese is used in connection with pitch, turpentine, and Gutta-percha for making Brandt's cement.

**MARBLE FLOUR.**—This is the finely ground chips of white marble, and is composed almost wholly of carbonate of lime. It is a heavy inert powder, often used in rubber compounding as a substitute for barytes. It has also been used to some extent in hard rubber, and in the manufacture of hones.

**MASSISOT.**—An oxide of lead, dull red orange in color. A higher degree of oxidation turns this into a product called Minium, which is its purest state. It is often used in rubber compounds, acting practically like litharge.

**MICA** is the name given to a group of complex silicates containing aluminum and potassium, generally with magnesium, but rarely with lime. Their specific gravity ranges from 2.8 to 3.2, while their color varies greatly. Ground mica is simply one or other of these micas reduced to powder. It is used in rubber compounding chiefly for insulating purposes. It is handled as a cement, compounded with rubber, and cut with benzine, or may be mixed dry on the grinder. It is also used in fireproof coverings in connection with rubber, and it is said that for a semi-hard result that is to come in contact with hot water, rubber and Mica

forms the best compound. Mica in a state of a very fine powder is also known as "cat's gold" or "cat's silver."

**MINERAL WOOL.**—Produced by sending blasts of steam through molten slag, which reduces the fluid metal to a fiber similar to the fused glass that is spun into glass silk. Natural mineral wool, such as is found in the Hawaiian Islands, is very brittle, but the artificial has considerable toughness. It is also known as slag wool, or silicate cotton. It appears in light fleecy masses, and at a distance looks like fine cotton batting. It is very cheap, but is easily affected by weak acids, and should be kept away from a moist atmosphere. It has not been largely used in rubber work as yet, but Lascelles-Scott strongly advises its use, giving as reasons its cheapness and its physical fitness. The sulphides present in it also assist in vulcanization.

**MINIUM.**—One of the oxides of lead, known also as Red Lead (which see). It is a scarlet crystalline and granular powder having a specific gravity of 8.6 to 9.1. On heating, it temporarily changes color to violet and black, but returns again to the scarlet on cooling. It is adulterated with oxide of iron and brick dust.

**MOUNTAIN FLOUR.**—See Infusorial Earth.

**ORANGE MINERAL.**—A red lead made from carbonate of lead, while red lead is made from litharge. As a general rule, it contains some lead carbonate. It differs from red lead in color, in that it is more orange red, and more brilliant. The reason for this difference is that it is less crystalline, its particles being much finer than those of red lead. The pigment is also more bulky and much smoother. It is used in finer grades of dark rubber, to assist the cure and impart resiliency.

**OXIDE OF ALUMINUM.**—See Alumina.

**OSSEIN.**—A light powder made from specially treated bone. Said not to be affected by acids. Is not affected by heat and is not hygroscopic. Preparation patented in England by J. F. Hunter.

**OXIDE OF ANTIMONY.**—There are really three of these oxides. The trioxide, one most useful in the arts, is a snow-white powder of the specific gravity of 5.2. It may be obtained by treating stibnite or, better still, powdered antimony metal with nitric acid, in a current of air sufficient to carry off the copious fumes arising during the operation, or by treating the chloride of

antimony with cold water for several days. A mixture of the trioxide with a small percentage of the insoluble peroxide may be obtained by melting antimony in a cast iron retort fitted with nozzles, through which air may be blown so as to bubble through the melted metal. Dense white fumes arise, which may be condensed in suitable chambers into a snow-white powder. This is used in coloring dental vulcanite.

**OXIDE OF GOLD.**—As a matter of curiosity it may be noted that this is the most costly ingredient suggested for rubber compounding. It occurs in two forms—the protoxide, a dark green or bluish violet powder, and the teroxide, a brown powder. The use of the protoxide was patented by Ninck. For dental vulcanite it is doubtful if either form of the oxide could be used, even if the price were so low as to bring it within reach. Another formula calls for the mechanical admixture of gold leaf, which is practicable—if one possesses the gold.

**OXIDE OF LEAD.**—See Minium and Litharge.

**OXIDE OF TIN.**—The article most frequently used in the arts is the dioxide. This is a white water-free powder, of the specific gravity of 6.7, insoluble in acids and such solvents as naphtha, petroleum, etc. It is infusible, except at a very high temperature, and is tasteless and inodorous. What is known as French Oxide of Tin is simply a carefully prepared and purified form of the dioxide. It is rarely used in rubber work, although Newton recommends it for a basic ingredient in rubber type. The other oxides of tin are at present merely of chemical interest.

**OXIDE OF ZINC.**—See Colors.

**OXYCHLORIDE OF LEAD.**—There are several oxychlorides of lead. The substance once known as Turner's Yellow and another known as Carsel Yellow were both of this composition. More recently a white compound has been prepared, which, from its covering power, has been used largely as a paint. Tarpaulin compounds consisting of India-rubber, coal tar, and pitch are treated with Oxychloride of Lead for surface drying, in lieu of vulcanization.

**PAGODITE.**—A mineral resembling steatite or soapstone. Its name comes from its having been used in the East as a material for carving miniature temples or pagodas from, as it is soft

enough to be cut with a knife. Its specific gravity is about the same as that of soapstone, and its color greenish white. (See Agalmatolite.)

PARIS WHITE.—This has exactly the same composition as Whiting, but is a much harder and more compact form of English chalk, and therefore has greater density. Spanish White is a coarser variety of the same material. Its uses are practically the same as those of whiting.

PETRIFITE.—A white powder composed of two inexpensive but secret substances. When mixed with water it solidifies quickly, and is an excellent binding substance. Mixed with marble dust, it is sometimes melted and cast upon glass or other smooth surfaces, and makes an excellent table-top in place of the zinc tables used in many rubber factories. As it is perfectly impervious to ordinary solvents, neither cement nor India-rubber sticks to it. It is manufactured in England.

PEROXIDE OF LEAD.—The highest oxide of lead—a dark brown powder with a specific gravity of about 9. It is easily decomposed, and from this characteristic it has a strong oxidizing action. Exposed to sunlight or to heat, it yields oxygen and passes into the lower oxide known as Red Lead. Its oxidizing properties make it a questionable ingredient in compounding rubber, although certain formulas call for its presence.

PEROXIDE OF MANGANESE.—Another name for Black Oxide of Manganese, which is a black powder having a specific gravity of 4.8. It is not readily acted on in ordinary ways, being unchanged by heat short of bright red. It is insoluble in the ordinary hydrocarbon solvents. Solvent naphtha was treated with Peroxide of Manganese by Humphry to free it from water. (See Manganese.)

PHOSPHATE OF LIME.—The chief constituent of animal bones, forming the bulk of the ashes of the same when burnt. It is a white powder, and when in crystalline mineral form, it has a specific gravity of 3.18. It is insoluble in ether, alcohol, or the benzine class of solvents. As it occurs naturally it is known as flour of phosphate and is used in part as a substitute for whiting. Bone ash made from animal charcoal is used in the same way.

PHOSPHORUS.—A non-metallic element or metalloid, although

in its combining relation it is more closely connected with arsenic and antimony than with any members of the sulphur group. It is found ordinarily in two states—the ordinary Phosphorus and the red variety. Ordinary phosphorus is an almost colorless or faintly yellow solid substance, somewhat resembling wax, and giving off a disagreeable odor. It fuses at  $111.5^{\circ}$  F. into a colorless fluid. Heated in the air to about  $140^{\circ}$  F., it catches fire and burns with a bright white flame. It dissolves freely in benzol, bisulphide of carbon, and in many oils. Red Phosphorus is an amorphous powder of a deep red color, with no odor, and may be heated to nearly  $500^{\circ}$  F. without fusing. Its specific gravity is 2.10. It does not take fire when rubbed, undergoes no change on exposure to the air at ordinary temperatures, and is far less inflammable than ordinary Phosphorus. It is insoluble in solvents of the ordinary Phosphorus, and is not poisonous. Mulholland made an insulated wire compound from shellac and India-rubber in solution, combined with one to two per cent. of Phosphorus, which he cured with chloride of sulphur. As cold-cure gums are of little value as insulators, his invention is of doubtful value. He also made a preparation of India-rubber, resin and tallow, and shoddy, to be applied in a fluid state where gas came in contact with the rubber, adding Phosphorus after his solution was finished, to prevent decomposition of the rubber. Duvivier also treated Gutta-percha with sulphide of phosphorus, claiming that he got an elastic result, but allowing that his compound was damaged by acid vapors, to neutralize which action he mixed carbonate of soda with it. An anti-fouling preparation of English origin was also made of Gutta-percha, turpentine, and a little Phosphorus.

**PIPE CLAY.**—A peculiar kind of clay containing neither iron, sand, nor carbonate of lime. It is a beautiful white, retaining its whiteness when burnt. It belongs to the group of clays. Its specific gravity is 2 to 2.5. It was used by Mayall in combination with Gutta-percha, India-rubber, zinc, shellac, and resin for insulating tape, and by Austin G. Day to absorb gases during vulcanization.

**PLASTER OF PARIS.**—This is prepared from gypsum or sulphate of lime. Its properties of hardening when made into a



paste with water are well known. Its chemical properties are the same as burnt gypsum. It is used sometimes instead of lime in compounding and also for making trial molds for rubber work. It was used in old fashioned dry heat compounds to prevent blistering. Specific gravity, 3.2. (See Anhydrite.)

PLUMBAGINE.—A dark colored pigment manufactured in England and sold to rubber manufacturers for the production of valves. By its use the rubber is vulcanized and goods made which are said to resist successfully the action of cheap lubricants. One pound of Plumbagine is used to two pounds of rubber.

PLUMBAGO.—This sometimes is called Black Lead, though having no relation to lead; it is also called Graphite. Its specific gravity is 2.1 to 2.2. Its color is black and shiny. It consists chiefly of carbon, but contains more or less alumina, silica, lime, iron, etc., varying from 1 to 47 per cent., but not chemically combined. Black Lead is a perfect conductor of electricity. It is more incombustible than most ingredients used in rubber compounding, and is capable of withstanding great heat. It is used in the rubber industry, chiefly in the manufacture of what are known as graphite or plumbago packings. It is a wholly inert substance, safe to use in connection with any compounds, and is not affected by heat or acids, alkalies, or corrosive substances. It is useful also in certain polishing compositions made with India-rubber as a base. German asbestos cements almost all contain a good proportion of finely powdered graphite.

PORTLAND CEMENT was first obtained by burning the mud found at the mouths of several large rivers in Europe with a proportion of clay and lime. Its composition is somewhat complex, containing: Lime 55 to 63 per cent., silicic acid 23 to 26 per cent., alumina 5 to 9 per cent., and oxide of iron 2 to 6 per cent., together with magnesia, potash, soda, sulphate of lime, clay, or sand in various small proportions, according to the mode of manufacture. Its value as a cement depends upon the interaction of the lime and the silicic acid. In compounding it would have no chemical effects upon rubber, but might of itself become much hardened and thus cause mechanical injury to goods in which it has been introduced. As it occurs commercially, it is a gritty powder of a gray brown or yellow brown color. Its only use as

far as known in rubber is where it is mixed with tar oil and waste rubber to joint pipes containing fluids.

**POWDERED COAL.**—Coal consists chiefly of carbon, and is universally regarded as being of vegetable origin. Various coals differ widely in their composition and characters, running from the softest kinds of earths to compact and solid bodies like Parrot coal, which is so compact and solid that it has been made into boxes, inkstands, and other articles which resemble jet. The average specimen of coal analyses is: Carbon 82.6, hydrogen 5.6, oxygen 11.8. Some curious compounds of India-rubber and Coal have been formed. One, for instance, was a mixture in which two pounds of waste India-rubber in a cheap solvent was mixed with nearly a ton of powdered Coal, in which was a certain amount of clay and peat, the use being for an artificial fuel; another use was in the production of hard rubber. Indeed, it is probable that the cheapest compound in use to-day is a jet black, semi-hard rubber made almost wholly of powdered bituminous Coal in which is incorporated a very small percentage of rubber. Coal that is to be used in any rubber work should be submitted to a chemist and its sulphur and other compounds carefully determined before use.

**PUMICE STONE.**—A light porous ashy stone, the product of volcanic action, its structure being that of a mass of porous glass. Its composition is a mixture of silicates of aluminum, magnesia, calcium, iron, potassium, and sodium, varying with the particular lava whence it had its origin. Its action on India-rubber will be quite inappreciable, chemically speaking, but its mechanical action will be that of a sharp cutting powder. Ground fine, it is used in the manufacture of erasive rubber, and is also used compounded with the rubber in the manufacture of bones. Recent patents call for its use in certain semi-hard compounds, its presence being said greatly to increase their toughness. Mixed with lard oil to a thick paste, this has been used for polishing India-rubber.

**PUZZOLANA.**—A porous lava found near Naples, used chiefly, when mixed with ordinary lime, in forming hydraulic cement. Compounded with marine glue, it is used as a varnish for preserving metallic articles from corrosion.

**RED CHALK.**—Artificially deposited chalk colored by any

suitable pigment—usually one of the red oxides of iron. (See Chalk.)

**RED LEAD.**—An oxide of the metal, which is also known as Minium. Prepared from pure massicot or from white lead. Its specific gravity is 8.6 to 9.1. A scarlet crystalline granular powder, of rather strong coloring powers. As a colorant in rubber work it would be unavailable, since the sulphur necessary to vulcanize would render it more or less black, owing to the formation of sulphide of lead. It is sometimes used, however, in place of litharge. It is also used in "hot" cements of Gutta-percha and for varnishes such as those made of India-rubber, linseed oil, etc., for covering the backs of mirrors. (See Minium, Massicot, and Orange Mineral.)

**ROTTEN STONE.**—Usually considered to be the residuum of naturally decomposed impure limestone, and varying in composition with its sources. That from Derbyshire, England, shows much alumina; other sorts have more silica. The name is sometimes given to "Tripoli," which is a species of infusorial earth. It can have no particular action on rubber, as it is very inert, but is used in certain packings, and was also used by Warne in insulated wire compounds.

**SELENIUM.**—A non-metallic element or metalloid of a dark brown color, analogous to sulphur. It has no smell, is tasteless, and is a non-conductor of electricity. It occurs rarely in nature, being found chiefly as a selenide in combination with lead, silver, copper, or iron. It is the basis of a process for vulcanizing India-rubber.

**SILEX.**—Pure Silica. (See Flint.)

**SILICA.**—The oxide of the metal silicon, familiar in the forms of flint, quartz, etc. Its specific gravity is 2.6. It is without action on India-rubber, except mechanically speaking. It is used in Chapman's vulcanite enameling solution, made of India-rubber, sulphur and silica. (See Flint.)

**SILICATE COTTON.**—See Mineral Wool.

**SLAG WOOL.**—See Mineral Wool.

**SLAKED LIME.**—Quick lime that has been treated with water, and allowed to absorb it from the air and crumbled to a fine powder. (See Lime.)

**SLATE.**—A soft easily laminated earthy material, chiefly aluminous in composition, and allied to the clays. Finely ground, it makes a good semi-hard valve of a blue gray shade. It has been also used in general rubber compounding.

**SOAPSTONE.**—A silicate of magnesia, combined with more or less alumina and water. It is really a massive form of talc. In color it is white, reddish, or yellow, is soft and greasy to the touch, is easily cut, but is hard to break. Its specific gravity is 2.26. It is used often in the place of French talc, for keeping rubber surfaces from sticking together during vulcanization, and also for burying dark colored goods and holding them in shape while they are being cured. Used as an adulterant for rubber, it makes an excellent semi-hard compound for valves. It is also used as a basis compound in the manufacture of insulated wire. (See Talc.)

**STARCH.**—A vegetable substance allied closely to cellulose. It occurs in regular lumps, composed of granules which have a definite character, according to the variety of the plant they were taken from. When dry its specific gravity is 1.53. Commercial starch contains usually about 18 per cent. of water and, if kept in a damp place, will absorb 33 per cent. of water. It was much used formerly on solarized work. Torrefied Starch is obtained by roasting the common form, and is used in artificial leather compounds.

**STIBNITE.**—That ore of antimony known usually as black antimony. (See Kermes.)

**SUBLIMED LEAD.**—Used in the rubber manufacture, it acts both as a filler and chemically. Its peculiar velvety fineness makes it mix intimately with the rubber, and gives a very fine finish, showing no shiny crystals on the surface. The oxide of lead in the Sublimed Lead will also bind free sulphur in the rubber. The amorphous state of the Sublimed Lead makes the action of the lead oxide in this much more effective than the action of litharge, and the result is a very smooth lively jet black rubber.

**SUGAR OF LEAD.**—See Acetate of Lead.

**SULPHATE OF LEAD.**—A white powder of the specific gravity of 6.2, insoluble in water, but readily soluble in caustic alkalies.



It is not a very stable compound. In Cooley's formula for artificial leather, which has Gutta-percha for a base, it is used in connection with dextrine, magnesia, and cotton dust.

**SULPHATE OF LIME.**—Also called Gypsum. A common mineral occurring under various forms and names as alabaster, selenite, and gypsum earth. It is pure white in color and has a specific gravity of 2.33. Plaster of paris is a burnt form of gypsum. In the ordinary recovery of rubber by the acid process, whiting becomes gypsum. (See Anhydrite.)

**SULPHATE OF ZINC.**—Also called White Vitriol. It occurs in the form of a transparent crystal containing about 44 per cent. of water of crystallization, 87 per cent. of which is not given up short of a red heat. Its specific gravity is about 2.03.

**TALC** or **FRENCH TALC** is a mineral allied to mica. It is composed entirely of silica and magnesia, in the proportions of 67 to 73 of silica, 30 to 35 of magnesia, and 2 to 6 of water. Its colors are silvery white, greenish white, and green. Talc slate is more like steatite and is used for similar purposes. French Talc is used very largely in rubber factories in all lines of work for preventing surfaces from sticking together, during either manipulation or vulcanization. It is used also sometimes for dusting molds to prevent the gum from sticking to the metal and is used largely to bury white goods and keep them in shape during vulcanization. It is used sometimes in compounding, but any great amount of it produces a stony effect. It makes, however, an excellent semi-hard packing. It is used further in compounds for soft polishing, with India-rubber as a binding material.

**TALITE.**—A white earthy material used in general rubber compounding. It is allied to diatomaceous earth, presumably, and has the same usage. Its analysis shows: Moisture 5.59, silica 83.9, sesquioxide of iron 1.2, alumina 2.8, oxide of manganese trace, potash trace, combined water and organic matter (by ignition) 6.47, loss and undetermined 0.04—total 100.

**TRIPOLI.**—See Rotten Stone and Infusorial Earth.

**WHEAT FLOUR** is used in making matrices for rubber stamp work, and sometimes as a compounding material in India-rubber, though this is not to be advised, as the flour is apt to



turn sour. A large and important use for it has been in the dusting of black goods, such as rubber coats, so as to keep them from sticking together, should they accidentally touch during dry heat of vulcanization. Wheat Flour is preferable to almost anything else, for the reason that it washes off after vulcanization, without leaving any trace in color or stain. It is, of course, used on the goods known as "dull finished."

WHITING or CHALK, as it is often called, is carbonate of lime. It is a white earthy material of the specific gravity of 2.7 to 2.9. It is made from English chalk, which is crushed, floated, and run through a filtering process, and dried in cakes, out of which, by a system of dry grinding and bolting, it is made in varying degrees of fineness. Where Whiting is kiln dried hastily, or under extreme heat, it is apt to become calcined, which gives it a hard, gritting feeling. Air dried Whiting is considered the best. Whiting is in reality a purified form of carbonate of calcium, of a very soft or flocculent quality. The finest grades are known as "gilders'" and "extra gilders'." It is used more generally in rubber compounding than any other material, except sulphur. Used moderately, it increases the resiliency of rubber, but adds to the hardness. It does not, however, produce the stony effect that many ingredients give. It is also the basis of the molds used in rubber stamp making; paste being made of whiting, wheat flour, glue, and carbolic acid. Whiting is liable to absorb considerable quantities of water from the air. It is customary in many mills, therefore, to keep it in large bins that not only are covered but have steam pipes in the lower portions to drive out any moisture from the material.

WHITE LEAD.—This is a carbonate and is a heavy white powder. It is unstable in color, however, as sulphur compounds, especially in the gaseous forms, easily attack it and blacken it by reason of the formation of sulphide of lead. Its specific gravity is 6.46. Sometimes it is adulterated with lead sulphate, chalk, carbonate, or sulphate of baryta, or pipe clay. The simplest test for the purity of White Lead is to heat it in a thin glass vessel with some very dilute pure nitric acid; if pure it will dissolve completely. If chalk be present it also

will pass into the solution, in which it may be detected by the addition of caustic potash, throwing it down as a white cloud. The best carbonate of lead is made by an old-fashioned process, by placing metallic lead, surrounded with spent tan bark, in stacks, where it comes in contact with weak acetic acid. The heat of the bark volatilizes the acid and oxidizes the lead, while the acetic acid changes the oxide into acetate of lead, and this in turn is converted into carbonate by the carbonic acid given off by the heated body. This process of corrosion requires from six to eight weeks. There are many later and more rapid processes; for instance, take either litharge or acetate of lead, and expose them to a current of carbonic acid gas, etc. The original "triple compound" patented by Goodyear consisted of India-rubber, sulphur, and White Lead. A White Lead known as sublimed lead is used very largely in the rubber manufacture. It is a fine white amorphous powder and imparts a decided toughness to rubber compounds. (See Sublimed Lead.)

#### UNUSUAL INGREDIENTS IN DRY MIXING.

It is not strictly accurate, perhaps, to say that it is unusual for fibers to be incorporated in rubber mixtures, for stocks made from unvulcanized rubber clippings have been used for years. Inner soles for rubber footwear and mats and molded articles have long been made of stocks of this kind, the fibers being cotton and wool, chiefly. Where wool was present there was oftentimes danger of blistering from the oil in the fiber, but this was easily gotten over by special compounding. In addition to the fibers already noted, silk, flax, jute and hemp—in fact, almost all of those in ordinary use—have been utilized, being added to the compounds to give toughness to them. The goods in which they are usually put are packings, artificial leathers, tire treads, and for wearing surfaces.

A fiber that has attracted considerable attention for this work, and one for which a number of patents have been granted, is cocoanut fiber, which is recommended for packings. Certain kinds of moss have also been used, as have sponge cuttings, peat, and wood pulp. This last-named ma-

terial has been used both in packings and in insulated wire compounds. It is also the basis of a curious artificial rubber that appeared several years ago, under the name of Maltha, but is not to be confused with the product that has become almost universally known by that name.

Sawdust of all kinds has also been incorporated in rubber, and was formerly used in making sponge rubber, until better compounds were discovered. Those who use vegetable fibers prefer them unbleached rather than bleached, and very often treat them to remove resins that may be present. A few of the many other vegetable substances that have been used are sugar and sugar charcoal and seaweed. (See Algin.)

Animal substances are also valuable, as for instance, animal charcoal (which see), whalebone, which is called for in some of the Woodite patents, fur, tan-hair, leather fiber, Currier's skivings, which are used in artificial leather, the white of eggs, etc.

Under the head of earthy and metallic ingredients, almost anything can be used, although some metals have a bad effect on rubber. The unusual earthy matters are powdered fossil iron-stone, Wisconsin mineral, coke ashes, Stourbridge clay, powdered granite, salt, powdered lithographic stones, powdered oyster shells, powdered schist; and in metals, steel, and all other common metal borings, filings, and turnings. These latter have been incorporated in packings as a rule. One packing in particular, which has had a world-wide reputation, was heavily compounded with brass filings.

The deodorization of rubber, and the neutralization either of the smell of the rubber or its solvent, has brought out also a curious line of ingredients. Musk, for example, has been used to disguise the earthy odor of Gutta-percha. Alcoholic infusions of sage-tea, lavender, and verbenia have been used in fine goods, while in powdered form, ginger root, birch, orris root, sassafras, marshmallow root, sandal wood, and other sweet smelling ingredients have been incorporated. The leaf of the mint has also been mingled with copperas, and placed in dry heaters, while a more expensive process was that pursued by Hill, who passed a current of hot air over perfumes and into the heaters. It must not be imagined that the ideas expressed in the foregoing are

unworthy of the consideration of those who make ordinary cheap mechanical goods, for certain of these ingredients are used to-day in mechanical mixtures to overcome the odors of African rubbers. Essential oils and gums are also used for the same purposes, the descriptions of which will be found under their proper departments.

Medical science has also added its list of ingredients to rubber compounding, chiefly in the line of adhesive plasters, where ingredients like dry mustard, menthol, capsicum, belladonna and a great variety of other medicaments are incorporated with the rubber.

## CHAPTER VI.

### I. SUBSTITUTES FOR INDIA-RUBBER AND GUTTA-PERCHA.

RUBBER SUBSTITUTES, as a rule, are made from oxidized oils. Those used most generally are made from linseed, rapeseed, cottonseed, mustard, peanut, or corn oils, acted on either by chloride of sulphur or by sulphur boiled with the oil at a high temperature. Substitutes have been known nearly fifty years, and have been made the subjects of many patents, but only within the last twenty years have they come into general use. French manufacturers have long exported these goods; they were really the first to produce them commercially. The fact that Europeans were unable at first to get the results with reclaimed rubber that were secured in the United States, led them to go further in their experiments with oxidized oils and to exploit their uses more thoroughly. The substitutes on the market to-day are, as a rule, white, brown, and black. They are often of the same specific gravity as pure India-rubber, so that their presence cannot be detected in rubber compounds by specific gravity tests. Substitutes of this type are easily analyzed by the expert chemists, and the results of such analyses are of value to rubber manufacturers. The table on the next page, containing analyses of typical sorts of substitutes, is adapted from Dr. Robert Henriques\*.

It would be a mistake to suppose that rubber substitutes are of no value, for they possess certain very distinct advantages not found in simple mineral adulterants nor possessed by the bituminous products now in use. Their value, of course, is where they cheapen stock without seriously injuring its durability or changing its texture. Among the wiser of the manufacturers, where substitutes are compounded with rubber they are used in small quantities, sometimes only 5 per cent. being added, and rarely is more than 25 per cent. to be found in a good compound.

\**Journal of the Society of Chemical Industry, 1904, page 47.*



# ANALYSIS OF OIL SUBSTITUTES.

OILS VULCANIZED WITH S <sub>2</sub> Cl <sub>2</sub> .	Sulphur.	Chlorine.	Water.	Residue on Ignition.	Fatty Acids.	Iodine Value.	Acetyl Value.	FATTY ACIDS.		
								Sulphur.	Chlorine.	Iodine Value.
<i>Substitute from :</i>	<i>Pr. Ct.</i>	<i>Pr. Ct.</i>	<i>Pr. Ct.</i>	<i>Pr. Ct.</i>	<i>Pr. C.</i>	<i>Pr. Ct.</i>	<i>Pr. Ct.</i>	<i>Pr. Ct.</i>	<i>Pr. Ct.</i>	<i>Pr. Ct.</i>
Linseed oil (raw oil) .....	9.34	8.84	3.02	.....	79.6	56.3	21.0	9.88	Trace	160.3
Linseed oil (blown oil) .....	4.78	4.85	0.85	.....	81.67	52.6	19.6	4.06	0.60	141.2
Rape oil (commercial oil) .....	8.28	7.62	.....	.....	86.89	32.5	31.0	8.34	Trace	121.0
Rape oil (blown oil) .....	6.59	5.95	.....	.....	87.95	26.9	.....	6.54	Trace	101.5
Poppyseed oil (blown oil) .....	7.68	7.44	.....	.....	74.90	33.6	.....	8.32	.....	102.8
Cottonseed oil (blown oil) .....	6.23	5.36	.....	.....	.....	30.3	51.3	6.44	Trace	133.3
Castor oil (with minimum S <sub>2</sub> Cl <sub>2</sub> ) .....	4.82	6.70	.....	.....	85.35	35.2	.....	5.32	Trace	91.5
Castor oil (with maximum S <sub>2</sub> Cl <sub>2</sub> ) .....	10.60	8.95	.....	.....	.....	21.9	105.6	.....	0.26	136.2
<i>Commercial products :</i>										147.4
White substitute No. 1 .....	6.4	5.0	0.85	0.8	90.45	30.9	.....	6.12	0.83	152.1
White substitute No. 2 .....	6.17	5.86	1.0	5.51	73.58	31.0	.....	6.45	0.43	105.6
White substitute No. 3 .....	8.25	8.88	.....	.....	.....	32.6	.....	8.15	.....	91.3
Brown substitute No. 1 .....	15.48	0.7	.....	.....	.....	42.0	.....	14.14	.....	102.3
Brown substitute No. 2 .....	17.71	0.36	.....	.....	.....	42.0	.....	15.20	.....	129.0
										125.6

Many substitutes, made from sulphurized drying oils, shorten the life of goods materially, by oxidizing the rubber. Manufacturers have learned, however, to avoid those that have this fault, and are becoming more and more expert in the use of these goods, as they have become in the use of the cheaper grades of African rubber and reclaimed rubber.

The list in the accompanying table has been made quite comprehensive, not because all the substitutes described are deemed valuable, but rather to give a broad view of the subject. It will be noticed that many of these gums are far out of the line of sulphurized oil experiments. Resins, glues, asphalt, cellulose, seaweed, bastard rubbers, animal substances, etc., have all been called upon, and some of the treatments have been as original as the ingredients are unusual. To the end that the perfect substitute may be found, and with the fullest appreciation that anything which suggests new experiments has its value to the manufacturer, many that otherwise would be ignored are given here.

**ADAMANTA.**—The American name for a German substitute for India-rubber, made from linseed oil, sulphur, lime, and resin. It is a thick, black, gummy mass, with an odor similar to that of most of the sulphur oil substitutes, and showing a bright cleavage. It was at one time used largely in France and Germany, and introduced to some extent into the United States. Its chief use was in cheap mechanical rubber goods, and for insulation.

**ADHESOR.**—A sticky substitute used to a certain extent in frictions.

**ADIRONDACKITE.**—A rubber substitute presumably made of sulphurized oil for use in proofing cloth and also an insulator. Invention of a chemist in New York State.

**ALGIN GUM.**—A gluey, leathery substance, manufactured from seaweed. It is insoluble in cold water, alcohol, ether, and glycerine, and combines readily with alkaline and metallic bases to form substances, many of which are soluble. Algin can be used for waterproofing compounds, as it combines easily with rubber, shellac, and other gums. With many

metallic bases it forms insoluble compounds as tough as horn or as pliable as Gutta-percha. It is an English product.

AMBER-RESIN SUBSTITUTE.—An English patented substitute made of Amber-resin dissolved in castor oil, heated with a little sulphur. Is treated with ozonized air after cooling. The mass then treated with chloride of sulphur in the presence of a solvent, calcium carbonate being also added.

A. R. D. GUM.—So called because it is used as an anti-dry-rot compound. It is manufactured of 112 parts glue, 56 parts resin, 10 parts boiled linseed, and 35 parts water. In some cases it has also been mixed with India-rubber in general compounding. Patented by J. F. Ebner, London, England.

ARTIFICIAL ELATERITE.—Made from liquid bitumen by incorporating with it vegetable oils, such as cottonseed oil, palm oil, rapeseed oil, etc. The product is treated with the aid of heat and pressure, with chloride of sulphur, saltpeter, and sulphur, which produces an oxidization of the fatty substances. The result is an elastic rubber-like or leathery mass, which is soft, spongy, and gluey. This gum is said to be far more elastic than the best samples of mineral rubber, and is useful for waterproofing and insulation. Patented by W. Brierly, in England.

ARTIFICIAL GUTTA-PERCHA.—A French compound made of 50 parts copal, 15 parts sulphur, 30 parts turpentine, and 60 parts petroleum. While mixing the heat reaches 100° C.; it is then cooled to 35° C. Then there is added a solution of 3 parts caseine, in weak ammonia, and a little methylene, and reheated to 120° C. It is then boiled with a 15 or 20 per cent. solution of tannin, and 15 parts ammonia. After several hours' boiling it is washed and cooled.

BORCHERDT'S compound for dolls' heads consists of 5 pounds glue, 10 pounds sugar, 2½ pounds glycerine, 3 pounds Perry's white.

BLACK GERMAN SUBSTITUTE.—Made of boiled linseed oil and sulphur, together with resinate of lime. This gum is similar to Adamanta, and has been practically driven out of the market by lighter substitutes.

BLANDITE.—An artificial India-rubber invented by Dr. A. L. Blandy, of London. It is fairly elastic, stretching to about

twice its length, and returning readily. It is very pliable and does not show signs of cracking when bent. It is vulcanized like ordinary rubber, and can be molded into any form desired. Coated on cloth, it strongly resembles leather. It is water-proof, and is used for gas tubing, mats, etc. In its crude form, it is a liquid mass resembling molasses. Dr. Blandy's patent describes the compound as made preferably of linseed oil which has been reduced by oxidation; then 10 per cent. of bisulphide of carbon, to which has been added 10 per cent. of chloride of sulphur, is mingled with the oil, and brought by gentle heating to the desired consistency. Trinidad asphalt, cleansed and reduced to powder, is combined under the heat in the proportion of 3 parts to 1 of oil. Care must be taken to avoid fire in heating. These proportions are gradually brought, by heat and stirring, to a liquid or thin state, and when in this condition it must be poured upon a wet, cold surface, and thus cast into sheets, convenient for subsequent mixings.

**CAOUTCHENE.**—A French substitute consisting of 100 parts sun-flowerseed oil, 25 parts chloride of sulphur, and exposed to air ten days, when it becomes yellow and elastic. To this is added Matesite, a Madagascar gum, and then Isoprene is added.

**CARROL GUM.**—A well-known sulphur oil substitute used in the United States. In smell it has all of the characteristics of the sulphurized oil products. It is produced usually in granular form, and is very black.

**CARBO-NITE.**—A material used for soft insulation, the basis of the product being cottonseed oil.

**CEREAL RUBBER.**—Wheat treated with ptyalin. The invention of William Threnfall Carr, of England. It is a gluey product which after it comes from the so-called vulcanizing press is said to be both plastic and waterproof.

**CHICLE SUBSTITUTE.**—A specially prepared gum-carbo or cottonseed oil substitute. Said to be very largely used by manufacturers of chewing gum. (See Gum-carbo.)

**CHINESE WOOD OIL SUBSTITUTE.**—A German invention

F. for eight hours, then vulcanize with chloride of sulphur.

CHRISTIA GUM.—An English substitute for Gutta-percha or India-rubber, used as a surgical dressing. It is said to be composed of hemp fibers, so treated as to be impervious to both alcohol and water. Dieterich analyzed a sample of the product, and said that the fibers were sulphite wood pulp, and that the coating was made from chrome gelatine treated with glycerine, or the well known compound of glue, glycerine, and bichromate of potassium.

CON-CURRENT RUBBER.—Invention of Julius Nagel, of New York. A secret compound, the basis of which is linseed oil and resins.

CORKALINE is made of glue, glycerine, ground cork, and chromic and tannic acids. It is of English derivation and is used as a substitute in mat work.

CORN OIL SUBSTITUTE.—A sulphurized oil substitute similar to that made from oxidized linseed or rapeseed oils, manufactured from corn or maize oil. It is the cheapest oil substitute that has yet been put on the market. It is made in two colors, brown and straw color, and is used in large quantities in mechanical goods, and in proofing. A good example of this type of substitute is that known on the market as "Kom-moid."

DANKWERTH'S RUSSIAN SUBSTITUTE.—This is said to be a perfect substitute for both Gutta-percha and India-rubber, and is used for covering telegraph cables. High temperatures do not affect it. It is made of 1 part by weight of the mixture of equal parts of wood tar, oil, and coal tar oil, with 2 parts of hemp oil heated until the mass is of the right consistency. Then 1-3 part by weight of boiled linseed oil is added. To this is added a little ozocerite and some spermaceti. It is then heated again, and finally a little sulphur is added.

DOEBRICH'S COMPOUND for dolls' heads consists of 1 pound glue,  $\frac{1}{2}$  pound glycerine,  $\frac{1}{2}$  pound sugar, and 1 tablespoonful pulverized flour, with a little albumen and coloring matter.

ELASTEINE.—An elastic substance produced through the treatment of certain resins. Solid and semi-solid copal resins are treated with oleic acid (found in stearine works), which



entirely dissolves them. The product of the solution is soluble in spirits of turpentine and in oil. This solution of gums in oleic acid gives an opportunity to produce materials that have sometimes the elasticity and the consistency of India-rubber. The inventor advises their use in insulating wire and in various kinds of proofing. It is of French origin, and patented by M. Louis Riviere.

ELASTICITE.—Trade name for an American corn oil substitute.

ELASTITE.—A brown rubber substitute of German origin of the sulphur oil type.

ELASTIC GLUE.—A mixture of dry glue and glycerine in equal parts, by weight. As little water should be used as possible in its manufacture. It is used for elastic figures, galvano-plastic molds, etc. It is not waterproof, nor will it stand a high degree of heat.

ELATERITE.—See Artificial Elaterite.

EUPHORBIA RUBBER.—J. G. Boles reduced Euphorbia gum to a fine powder and, after drying carefully at a low temperature, put it in solution and finally hardened it by mixing it with earthy matters and shellac. The same gum before that he mixed with a preparation of rubber and cured it, forming a kind of vulcanite.

FAYOLLES' SUBSTITUTE.—A French substitute for water proofing, made as follows: 1 part sulphuric acid, 1 part glycerine,  $1\frac{1}{2}$  parts Formalin, 1 part phenol.

FENTON'S ARTIFICIAL INDIA-RUBBER.—Manufactured from linseed or similar oils, mixed with tar, pitch, or other forms of pyroligneous acid, the mixture being placed in a bath of diluted nitric acid, and allowed to remain for maceration until, by the action of the bath upon the compound, the whole is coagulated into a tough, elastic magna. The black "Fenton" contains as a coloring matter a small quantity of plumbago or black carbonate of iron. The gum is patented by Ferrar Fenton, London, England. In his specification he modifies it by taking the artificial gum described, and placing it in a bath composed of a solution of sugar of lead, oxide of zinc, salt-peter, or some other form of nitrate, and, if high flexibility is

desired, adds 5 to 10 per cent. to copal gum and nitric acid diluted with water. These solutions are used one at a time, the proportion being 5 per cent. of sugar of lead, or, for greater hardness, 5 to  $7\frac{1}{2}$  per cent. of saltpeter to the weight of the magna. Before vulcanizing, the substances are washed in an alkaline solution to remove acid. Fenton rubber is said to have been subjected to  $320^{\circ}$  F. for fifteen minutes, the only result being to increase its elasticity.

**FIG JUICE PROOFING.**—A French composition made up of fig juice, Brazilian tapioca, and pearl moss, together with vulcanized rubber. Used as a preservative and proofing compound.

**FIRMUS.**—An English rubber substitute presumably of the sulphur oil order.

**FRANKLIN SUBSTITUTE.**—A mixture of coal tar and boracic acid dissolved in alcohol. Boiled and oxidized.

**FRENCH GUTTA-PERCHA.**—This gum is made by boiling the outer bark of the birch tree in water. The result is a fluid, which is very black, and which becomes compact and solid on cooling. It has been claimed that it possesses all of the good properties of Gutta-percha, and that in addition it does not oxidize when exposed to the air. Its application for industrial purposes has been patented.

**GRAPE RUBBER.**—A high grade or artificial rubber, produced from the skins and seeds of grapes from which wine has been extracted by pressure. Small samples manufactured in the laboratory are said to be almost identical with pure rubber. It has been impossible so far to make the material on a large scale economically and, therefore, none of the gum is on the market.

**GRISCOM'S SUBSTITUTE.**—A substitute composed of equal parts of animal fat, candle tar, and a residual product from petroleum together with sulphur in proportions of from 2 to 8 per cent. of the mass.

**GUM-CARBO.**—Substitute made from cottonseed oil. Used in general rubber compounding.

**GUM FIBRINE** is made of paper rags, treated with liquid carbonic acid, mixed with resin and gum benzoin and castor oil, dissolved in methylated alcohol. It is an English compound.

GUTTALINE.—A substitute for India-rubber and Gutta-percha, manufactured as follows: To Manila gum tempered with benzine is added 5 per cent. of Auvergne bitumen, also mixed with benzine. Then add 5 per cent. of resin oil, and allow 48 to 86 hours to pass between treatments. The product obtained is similar to India-rubber. If it be too fluid, the addition of 4 per cent. of sulphur dissolved in bisulphide of carbon will act as a remedy.

GUTTA-PERCHA SUBSTITUTE.—Formula: 2 parts paraffine, 2 parts pitch,  $2\frac{1}{2}$  parts Chinese wood oil, 1.1 parts chloride of sulphur, 0.1 flowers of sulphur. Heat to 100° C. for one hour.

HALCOX.—A so-called artificial rubber, the invention of H. B. Cox, of Hartford, Connecticut. Claimed to be almost identical with crude rubber, but much cheaper.

HYDROCARBON RUBBER.—The invention of Eugene Turpin, of England. Made by heating a vegetable oil, oxidizing by air current, adding 25 per cent. by weight of resin, 25 per cent. powdered sulphur, 5 per cent. spirits of turpentine, and 1. to 2 per cent. carbon chloride.

HYDROLAINE.—One of the original waterproof fabrics made by means of India-rubber dissolved in spirits of turpentine and spirits of wine in equal quantities, and deodorized by oil of wormwood.

INSULITE.—A preparation made of wood or vegetable fiber, finely ground and dessicated, and saturated with a mixture consisting of melted asphalt, incorporated with substances of the resin type, with or without substances of the paraffine or anthracene types. The products resulting are used as substitutes for India-rubber, particularly in insulation. Patented by Alfred H. Huth, London.

JONES'S SUBSTITUTE.—An English substitute made of treated psuedo gums. Marketed by the Rubber Substitutes Syndicate, Limited, of London.

JUNGBLUTH'S COMPOUND.—Calcium carbonate 75 per cent. Trinidad asphalt 20 per cent., Selenite 5 per cent. In place of Trinidad Asphalt, neutralite, an asphaltic material made in Berlin is sometimes used.

KELGUM.—A linseed oil preparation manufactured in the

following way: First, boiling linseed oil in a nitric acid bath until it reaches a gum-like condition; second, subjecting the gum to a bath for the removal of the acid; third, cutting the gum in a solvent bath; fourth, disintegrating the gum with the solvent; fifth, grinding the disintegrated mass; sixth, boiling the material; seventh, subjecting the same to another boiling, and adding a drier. Used in proofing compounds. Invented by Henry Kellog, United States.

**KERITE.**—A compound of vegetable oils, coal tar, bitumen, and sulphur, to which are added sometimes a little camphor and various waxes. Occasionally sulphide of antimony is used in place of sulphur. Vegetable astringents, such as tannin, the extract of oak bark, etc., are also used in small quantities to impart toughness. Kerite is the invention of Austin G. Day, and has been used largely for the manufacture of a covering for insulated wire. A later patent taken out by W. R. Brixey, changes the original Kerite compound somewhat. Cottonseed oil is eliminated and talc added. The later compound is as follows:

MIXTURE FOR 180 POUNDS.		
Coal tar .....		25 pounds.
Asphalt .....		15 pounds.
Heat together to 350° F. for $\frac{1}{2}$ hour; then add—		
Linseed oil .....		70 pounds.
Heat again to 350° F. for 7 hours; let stand over night; heat up to 240° F., and add—		
Sulphur .....		10 pounds.
Heat up to 320° F. in $\frac{1}{2}$ hour and add—		
Sulphur .....		4 pounds.
Heat again to 300° F. and add—		
Talc .....		56 pounds.
Keep at same temperature $\frac{1}{2}$ to $\frac{3}{4}$ hour, when vulcanization will have taken place, and the mixture can be poured into molds or allowed to cool in mass.		

**KOMMOID.**—See Corn Oil Substitute.

**LICONITE**, produced in Holland, is described as a mixture of bitumen and various oils, without India-rubber or Gutta-percha, elastic and tough, and is claimed to be unaffected by water, dilute acids, and alkalies, and neither flows nor cracks in ordinary temperatures.

**LINOXIN.**—An insoluble oxy-compound produced by the oxidation of certain drying oils boiled in acetone or acetic acid,

from which is produced an elastic mass similar to India-rubber. Of French origin.

**LUGO RUBBER.**—An artificial oxidized oil substitute that originated with Dr. Lugo, a German chemist, who introduced it into the United States, where it once had a large sale. It was black, of about the same specific gravity as India-rubber, and made, in connection with rubber, excellent mold work. It is not now on the market.

**LUGO.**—A rubber substitute patented in England, made by heating a mixture of oxidized oil and rubber to a temperature at which the rubber dissolves. Potassium permanganate is added, and the whole heated to 360-400° F. Finely divided waste rubber is added, the mass being stirred and the temperature maintained. To obtain a harder product sulphur may be added.

**MAPONITE.**—A substitute for India-rubber and Gutta-percha, claimed to be capable of use in the manufacture of golf balls, tobacco pouches, etc. It is said to be vulcanizable at 260° F. An English patent was applied for by F. E. MacMahon.

**NIGRUM ELASTICUM.**—A sulphurized oil substance apparently made from linseed oil. Very dark colored and quite hard. Of English origin.

**NOVELTY RUBBER.**—An English substitute invented by David Lang. It is made red and drab in color. It comes in small slabs about 18 inches square and 2 inches thick, weighing about 7 pounds. It is said to be easily mixed with ordinary rubber, vulcanized in the usual way, the price being about the same as for reclaimed rubber.

**OXOLIN.**—An English invention patented by Charles J. Grist, an electrical engineer, and identical with "Perchoid" in the United States. This gum is used for waterproof sheeting, printers' blankets, packings, etc. It is made of a solution of partially oxidized oil by adding litharge and heating to over 400° F. Jute, or other fibers, is then dipped in the oil, the surplus oil is removed in a hydro-extractor, and the oil remaining on the fibers is oxidized by a current of air. These operations are repeated twice. The material is then ground with sulphur and coloring matters, and treated like India-rubber.



**PARKESINE.**—Made from a compound of linseed oil and pyroxyline, and used in the manufacture of small articles that are sometimes made of hard rubber. A Parkesine compound for molding, proofing, etc., is as follows: To 500 pounds water add 50 pounds sulphuric acid, and steep in it as much cotton, or rags, or jute, or linen as the liquor will moisten, for 3 or 4 hours. Take out, drain, and expose the mass to steam heat of about 280° F., for an hour, if cotton or jute fiber has been used, and 3 hours if flax. Neutralize the acid pulp with a bath of water and soda, using 4 pounds of carbonate of soda to every 200 pounds of rags. Wash and press, pass through a coarse sieve of 12 meshes per inch, and dry. Grind the granulated material and sift it through a sieve of 120 meshes to the inch. The resulting powder may be mixed, in all proportions up to equal parts, with fresh rubber. Compounding 25 to 50 parts dry Parkesine, with 50 parts alcoholic solvent. A proofing compound is: 1 pound paraffine, linseed oil, or other drying oil; 4 to 8 ounces Parkesine.

**PARAGOL.**—A high grade oil substitute, the basis of which is probably corn oil.

**PENSA'S RUBBER.**—A French substitute made as follows: 100 parts of boiling coal tar, petroleum tar, oil of turpentine, or mineral oils, and 25 parts of boric, or phosphoric acid dissolved in alcohol, and the vapors are ignited, and the flame extinguished as soon as a green color is seen. The mixture is then heated at 60° C. in the presence of oxygen, until a viscous ductile substance is obtained.

**PERCHOID.**—See Oxolin.

**PEROXIDE SUBSTITUTES.**—Peroxide of lead having been recommended as a better drier than other oxides used in connection with all compounds, the following formulas are given: 25 parts of walnut oil, 62 parts linseed oil, 5.5 parts peroxide of lead, 7.5 parts sulphur. One of the greater toughness is composed of 25 parts walnut oil, 56 parts linseed oil, 5 parts peroxide of lead, 6 parts sulphur, 6 parts gum juniper.

**PICKEUM SUBSTITUTE.**—This is made by the following treatment of Pickeum gum:

A	
Boiled linseed oil .....	160 pounds.
Vaseline .....	20 pounds.
Bastard gum (or Pickeum gum) from Central America, cut fine .....	40 pounds.

Stir and heat to 250° to 300° F., until the gum is dissolved. Then cool to 100° F., and strain.

B	
Mixture of { Solution as above .....	5 gallons.
{ Protochloride of sulphur .....	9 pounds.
{ Bisulphide of carbon .....	9 pounds.

After the chemical action takes place, the mass is granulated and the grains are washed and stored for use, or the material may be masticated in a rubber mill and run into sheets for use.

**PURCELLITE.**—The invention of Dr. C. Purcell Taylor, of England. An insulating substance somewhat similar to Gutta-percha, but costing much less. It is said to be very tough and elastic, may be made of any color, and is either flexible or rigid. The specific gravity of the material is 1.2. It can be molded or vulcanized like India-rubber. Its insulation resistance is equal to that of Gutta-percha. It is unaffected by atmosphere, by alkaline or acid liquids, freezing mixtures and the like.

**QUINN'S RUBBER.**—An English substitute made from petroleum, bisulphide of carbon, chloride of sulphur, and rapeseed oil.

**RESINOLINES.**—Substances so called by Eugene Cadoret, of Paris, who obtains them by saponifying various oils by the use of a metallic carbonate, using by preference carbonate of lead, then decomposing by nitric acid, decanting, and saturating with an alkali. The soap thus formed is treated with acid to form a resinoid body, purified by dissolving in alcohol, and evaporating the solution. Resinolines thus formed are very similar to natural resins. They are either semi-fluid, pasty, or solid. When solid, they are remarkable for their flexibility.

**RHEA GUM.**—Rhea fiber washed and dried; immersed in a solution of silicate of soda; then carefully dried; then immersed in a bath of resin or other heavy hydro-carbon oil at a temperature of about 275° F.; then put in a hydro-extractor

which is worked at a temperature of 300° F., when the superfluous oil is extracted; the mass is then dried. Later it is mixed with gums, resins, India-rubber, or Gutta-percha, and Rhea gum is the result.

**RICE RUBBER.**—Japanese or Machi rice treated so that it makes an elastic cellulose product.

**ROSALINE.**—A vegetable product said to contain about the same chemical elements as India-rubber, and of about the same specific gravity. Manufactured in the United States, France, and England. A strong point is made by the manufacturers that after vulcanization no chemist is able to detect that there is anything but pure rubber in a mixture containing 25 per cent. of Rosaline and 75 per cent. of India-rubber. In vulcanizing, it requires about one-third more time to bring about the usual result.

**RUBERINE.**—An American rubber-like solution used as an insulation paint, and also as a proofing mixture, and partaking of many of the qualities of ruberoid. It is also manufactured in Germany.

**RUBEROID.**—An American substitute for India-rubber that has the physical appearance of a high grade of black oil substitute. In use, however, it differs from many of them, for the reason that it has been found useful in vulcanite compounds, while at the same time it may be used in ordinary soft rubber work.

**RUBBERITE.**—An artificial rubber of the same specific gravity as fine Para. In color, elasticity, capability for vulcanization, and durability, it is said to resemble the higher grades of rubber. It is the invention of H. C. B. Graves, London, and is made up as follows:

Trinidad asphalt .....	47 to 80 per cent.
Oxidized oil .....	20 to 30 per cent.
Vaseline .....	5 per cent.
Sulphur .....	15 per cent.
Chloride of sulphur .....	3 per cent.

**RUBBERAID.**—An amber colored substitute manufactured from cottonseed oil by a secret process, which removes what the inventor calls the grease, leaving an elastic semi-solid which has been used quite largely in compounding.

**RUBBER FLUX.**—A semi-fluid compound of a dark color and presumably made from non-drying, non-volatile oils. It is used in compounding where the stocks are dry in place of palm oil, for example. Is said to prevent oxidation and bloom.

**RUSSIAN SUBSTITUTE.**—Manufactured from the skins of rabbits and other small animals, or the waste therefrom, digested in crude glycerine, and a little water. The formula is 3 parts by weight of the cleansed substance melted in water, with 3 parts by weight of crude glycerine, to which is added  $\frac{1}{4}$  part by weight of a concentrated solution of potassium chromate. The resultant mass is flexible. To make it harder, a little less glycerine and more chromate of potash are required. To withstand acids, 30 per cent. of gum lac dissolved in alcohol is added. For waterproofing fabrics,  $\frac{1}{4}$  part by weight of oxgall is added, with enough salt water to give it the consistency of oil.

**SOAP SUBSTITUTES.**—These have been exploited and explained more thoroughly by Professor W. Lascelles-Scott than by anybody else. The typical formulas that he gives are as follows: 28 parts of aluminum soap, 60 parts of linseed oil, 8 parts of acid free sulphur, 4 parts of oil of turpentine. Another, to use in connection with reclaimed rubber, is 15 parts of aluminum soap, 25 parts of devulcanized rubber, 60 parts fresh rubber, benzine *quantum sufficit*. Another still, in which a low grade pseudo gutta is used, is 15 parts aluminum soap, 25 parts Almeida gum, 5 parts raw rubber, 6 parts sulphur, and 4 parts oleum succini.

**SOLICUM.**—A substitute or rather a compound patented by a chemist in Copenhagen. The basis of the discovery is waste rubber and oil.

**SULO.**—A sulphur oil substitute manufactured in the United States.

**TEXTILOID.**—A mixture of a resinoline [as described by Cadoret under that heading] with natural resins, cellulose, nitric cellulose, or organic substances of animal origin. The resultant material may be transparent, white, or colored. It is practically unflammable, has no smell, is very elastic, and, if submitted to heat, softens, and can be easily drawn out into fine



threads. It can be used for waterproofing and in various other ways is a good substitute for India-rubber. It is flexible and elastic. Textiloid is made of 4 parts resinoline, 2 parts nitric cellulose, and 1 part camphor dissolved in alcohol at 90° F. The result thus formed may be made in colors by the addition of metallic oxides.

TONG OIL SUBSTITUTES.—Manufactured from the Chinese oil known as tong oil, or wood oil. The oil is heated without any foreign matter being added to it, at a temperature of 250° C., when it becomes solidified. It is then pulverized, and impregnated with petroleum, which swells it, and renders it more easily worked. Patented by Dr. Charles Repin, Paris.

TURPENTINE RUBBER.—Manufactured by passing spirits of turpentine through a heated tube so as to vaporize it, and mixing the vapor with hydrochloric or other acid, so as to condense and solidify all of the vapor. Patented by A. F. St. George, England.

TREMENOL.—A German invention that has reference to the production of sulphonic acids, sulphones, oils, resin oils, mineral waxes, etc. Results from a treatment of mineral matter with fuming sulphuric acids at ordinary temperatures, or with concentrated sulphuric acid at 120° C. The invention further calls for the treating similarly of the bodies obtained from the oil in their precipitation by means of sulphuric acid. The products are then washed in brine and water. The inventors precipitate glue and gelatine from a slightly acid solution, as elastic rubber-like substances that can be drawn into threads with perfect ease.

VELVRIL.—Basis, a drying or semi-drying oil; treated with strong nitric acid. This is compounded with nitro cellulose. By varying the proportions any consistency may be obtained from that vulcanite to a soft, elastic, rubber-like substance. The product is nearly colorless in thin layers, which shows an elasticity of about 25 per cent. but no great resilience. Invented by W. F. Reid, of England.

VOLTIT.—The base of this is glue or gelatine prepared from scraps of kid skins, which are treated until they reach a gelatinous mass, which is filtered and mixed with oleic acid,



such as is used in candle factories, the proportion being 80 parts of oleic acid to 20 parts of the gelatine. The mixture is boiled for  $\frac{1}{2}$  hour, and then 11 parts of caustic potash solution (in 50 parts of water) are added. The boiling is then continued for an hour, and a special mass is formed to which are added resin oil, oxidized linseed oil, and paraffine. The whole mixture is then boiled 4 to 5 hours. Also spelled Voltite. It is of French origin.

**VOLENITE.**—A substitute for India-rubber and Gutta-percha invented by Frederick Lamplough, United States. The compound is said to be a mixture of resins, or resin oil conveyed into a mass of fibrous material by a suitable non-oxidizable oil. This latter oil is used simply as a vehicle to carry the resin to its place, the process being completed by the distillation of the non-oxidizable oil, and the oxidizing of the rest of the mass. The oil used is preferably a fish oil, which is refined carefully before use. After saturation and treatment the vegetable fiber is changed into a homogeneous mass which has many of the characteristics of vulcanite. A formula that is said to have worked well is 10 parts by weight of fiber, 5 parts resin oil, and 2 parts fish oil, treated at a temperature of  $130^{\circ}$  C., for say  $4\frac{1}{2}$  hours.

**VORITE.**—A substitute containing no sulphur and no acid. The melting point for the soft grade is from  $300^{\circ}$  to  $400^{\circ}$  F., and for the harder grade  $550^{\circ}$  F. It is a floating substitute and burns without leaving any ash. It is made in three grades, which are distinguished by the names soft, ground, and white. According to the makers it absolutely resists oxidation and drying out, and is already largely used in the manufacture of insulated wire and in general mechanical rubber goods.

**WATERPROOF GLUE.**—A substitute for canvas proofing made as follows: Dissolve 16 ounces of glue in 3 pints of skim milk, and to increase its strength add a little powdered lime.

**WINTHROP GUM.**—Another name for Rubberaid.

**WICHMANN'S SUBSTITUTE.**—A combination of vegetable albumen and animal casein.

**WHEAT RUBBER.**—See Cereal Rubber.

**WOLFERT.**—A substitute for rubber made of felt impreg-

nated with a waterproof substance, presumably vulcanized oil. An English invention.

ZACKINGUMMI.—Substitute invented by Zachias Olsson, a Swedish chemist. Consists of a mixture of glycerine, chloride of calcium, magnesium, and paraffine.

## II. SUBSTITUTES FOR HARD RUBBER AND GUTTA-PERCHA.

HARD RUBBER in its best estate is so valuable and perfect a product that it would always have the preference were it not for its unavoidable high cost. Because of this cost there are many substitutes for it that counterfeit it in texture, color, and quality, but are never quite its equal in all these points of excellence. These substitutes are made of cellulose, gums, and animal, vegetable, and earthy matters, having a variety of distinctive names and varied uses. To the popular mind, if they look like ebonite, they are hard rubber. In the same way, Gutta-percha is often confounded with hard rubber, which it resembles under many conditions. The following list covers not only certain widely-known compounds of hard rubber and Gutta-percha, but a number of substitutes for them now put to many uses, the chief of which, perhaps, is insulation.

ALEXITE.—An American insulating material which can be molded in any shape, is waterproof, fireproof, and acid proof, and can be produced in any color. In texture and general appearance it resembles vulcanite.

AMBROIN.—A German substitute for hard rubber, consisting of fiber, silica, and resin compressed to a mass. Its color varies from light brown to green or black. Nitric and acetic acids do not affect it, and even aqua regia does not injure it. Under a moderate heat it softens slightly and can be worked, like vulcanite, in a mold. It also takes a bright finish from the buffing wheel.

ARMALAC.—See Insulac.

ARTIFICIAL WHALEBONE.—A well-known product made as follows: India-rubber 20 parts, sulphur 5 parts, shellac 4 parts, magnesia 4 parts, and gold brimstone 5 parts. Vulcanized somewhat the same as hard rubber.

**BAKELITE.**—A substance said to have the combined properties of amber, celluloid, and hard rubber. The invention of Dr. L. E. Baekeland. It is a compound of or condensation product of formaldehyde and phenol or carbolic acid. It has long been known to chemists that formaldehyde and phenol formed condensation products which have been put on the market as artificial gums and resins and used to some extent. It was further known that by a certain process this material was condensed into a hard resinous body which resisted every known chemical solvent and was only changed by actual burning. This substance was usually porous and was of no value. Dr. Baekeland discovered that, by carrying on the process in a vulcanizer where heat and temperature conditions could be controlled, the reaction could be divided into several stages, producing first, a plastic mass which can be molded or carved, and on further treatment in the vulcanizer where it is submitted with certain chemicals to carefully regulated conditions of heat and pressure, that a hard, transparent substance could be produced which is most inert chemically. This substance resembles physically and possibly chemically the Chinese or Japanese lacquer. It is being manufactured in considerable quantities and seems to have a future, but it is in no sense elastic and would take the place of nothing in the rubber industry except the hardest of rubber goods. It is singularly adapted, however, to manufacture in rubber works as most of the machinery can be used with little change. The invention is said to be fully protected by patents.

**BALENITE**, as the name signifies, is intended as a substitute for whalebone. It is quite elastic; in other words, it is neither hard nor soft, but may be characterized as semi-hard. A well-known compound for this is India-rubber 100 parts, shellac 20 parts, burned magnesia 20 parts, sulphur 25 parts, and orpiment 20 parts. (Hoffer.)

**BETITE.**—An English insulating material which is said to be bitumen refined to absolute purity and vulcanized. It is used on cables, in underground work, for low pressure resistance, and in rare instances for high pressure.

**BROOKSITE.**—A compound of resin and heavy resin oils for insulating purposes.

BROWN'S SUBSTITUTE FOR HARD RUBBER.—Made of bitumen, sulphur, lead peroxide, and gum camphor. Amalgamated by heat.

CAOUTCHOUC ALUTA.—A composition used as a substitute for hard rubber, made of leather scraps boiled in water, with a sufficient quantity of oxalic acid to dissolve them, and a portion of glue. To this are added resin, pitch, beeswax, and copal gum, dissolved in oil. India-rubber boiled in linseed oil is then added and a powder formed of plaster of paris, and a coloring matter is stirred into the composition to thicken and stiffen it.

CARBO-NITE.—A cottonseed oil preparation intended as a substitute for hard rubber.

CE-RE-GUM.—A compound made by a secret process, and which, vulcanized, produces a fairly good imitation of hard rubber. Invention of H. W. Morgan, United States.

CHATTERTON'S COMPOUND.—A widely-known compound sold the world over for connections for joint sheets and for uniting Gutta-percha parts, and also used for cementing Gutta-percha to wood. It softens readily at 100° F., and becomes firm again when cold. Its specific gravity is about 1.02. The best compound is 1 part by weight of Stockholm tar, 1 part resin, and 3 parts cleansed Gutta-percha, melted and mixed.

CORALITE.—A name for vulcanite which is colored to imitate coral.

CORNITE.—A specially hard vulcanite or hard rubber, so named from the Latin *cornu* (a horn).

DE PONT SUBSTITUTES.—An English patented product made from asbestos 30 parts, plaster of paris 5 parts, clay 8 parts, copal 15 parts, tar 5 parts, bitumen 15 parts, aniline 2 parts, lampblack 15 parts, mica 4 parts, wax 3 parts.

DIATITE.—A combination of diatomaceous earth, and shellac, made under very heavy pressure. It may be made of any color, and is used as a substitute for hard rubber.

ELECTROSE.—A substitute for hard rubber for which the following advantages are claimed: It will not tarnish metal, as no sulphur is used in its vulcanization; it is cheaper than hard rubber; it possesses high insulation properties; it can

be melted readily into any shape, or made of any color; it does not fade; it possesses great strength, and takes a high polish; changes of temperature do not affect it; and it withstands the weaker acids and alkalies.

**EBONITINE.**—A hard rubber substitute used for phonograph records. Is of a brilliant black color. Said to be a good insulator and resists acid. Of German origin.

**ESBENITE.**—Made of pure cellulose, chemically incorporated with mica in the form of fine powder, with the addition of magnesia and a silicate, thus forming strong and close grained artificial mica. It is flexible, and can be molded into any shape. Esbenite is waterproof, does not burn readily, and is thoroughly airproof. Manufactured in England.

**FIBRONE.**—A substitute for hard rubber which is a good non-conductor, waterproof, and can be handled in a lathe like vulcanite. It is said to be durable, does not contract or expand, and is made in all colors. It is used for thumbscrews, pushbuttons, etc. Plasticon is similar to Fibrone, but heavier and of a more stony nature, and probably made of the same material.

**HARD CORE FOR GOLF BALLS.**—An English composition which consists of 100 parts calcium chloride, 25 parts chloride of zinc, 100 parts potato starch.

**HYALINE.**—Made of a mixture of equal parts of gun cotton and a variety of resins. The gun cotton is dissolved in ether and the resins in solution are added, the result being a thick, gelatinous mass. When allowed to dry, this mass soon hardens and forms a horny, incombustible material. Invented by Frederick Eckstein, Vienna.

**INSULLAC.**—A spirit copal resin varnish, with the acids of the resins neutralized as much as possible, to prevent the resin acids from attacking the copper wire. It is a transparent elastic material, and is superior to shellac. Armalac is made of black paraffine wax, in solution in petroleum. It remains permanently plastic under heat, although it dries quickly and thoroughly. Manufactured in the United States.

**INSOLACIT.**—An insulating material produced either as a liquid, semi-liquid, or solid. It is not inflammable or affected



by corrosive acids, alkalies, saline substances, etc. It is a German product and the compound remains a secret.

IRON RUBBER.—A compound made from iron filings and petroleum residue.

ISOLATINE.—An American insulating material prepared especially for high resistances. It is said to be flexible, not to be affected by cold or heat unless the latter is artificial, and to be durable. It is also said to protect metal.

KEMPEFF HARD RUBBER SUBSTITUTE.—A mixture consisting of 20 per cent. resin and asphaltum, 15 per cent. china clay, 11 per cent. Kieselguhr. Mixture is allowed to cool; ground dry; with 4 per cent. of sulphur, and 50 per cent. of ground asbestos fiber. It is elastic and unaffected by acids.

KERATITE.—Another name for hard rubber, derived from the Greek word meaning horn.

KERATOL.—An American waterproof preparation, not of the nature of rubber, but probably one of the cellulose substitutes. It is a colorless transparent substance, and when applied to fabrics renders them waterproof and prevents crotching and fading. It also strengthens the fabric, and allows stains to be washed off. An artificial leather is also made of Keratol. The name is adapted from the Greek word *keros*, meaning hornlike.

KIEL COMPOUNDS.—One of these well-known compositions consists of India-rubber, sulphur, pumice stone, oil, and beeswax. The resultant compound makes a hard rubber, said to possess a superior elasticity and toughness, and capable of being vulcanized in sheets at least  $2\frac{1}{2}$  inches thick. This compound is not affected by the most intense cold, and will stand a higher temperature than ordinary rubber. It also burns with difficulty. Its ingredients are said to mix faster and more uniformly than those of other compounds. It resists acids, and other corrosive substances, is a perfect insulating material, and is cheap. Another Kiel compound is made of India-rubber, sulphur, and mineral oil. The resultant compound is more flexible than ordinary hard rubber, and when warm is more plastic than such compounds. It is also less brittle and cheaper, and can be turned in a lathe with greater facility and less injury to the tools.

**KORNITE.**—A Russian substitute for hard rubber made at Riga. It consists of 25 per cent. of prepared fish bone and 75 per cent. of scrap horn ground to dust, and then melted under high pressure and steam heat.

**LAMINA FIBER.**—An American invention, used chiefly for electrical purposes. It is of various colors, heavier than vulcanized rubber, and swells to nearly double its weight when placed in water. It is probably a cellulose compound containing no rubber.

**LACTITIS.**—An artificial ivory made from milk, the process being coagulation, straining, and rejection of the whey. Ten pounds of the curd are then taken and mixed with the solution of 3 pounds of borax in 3 quarts of water. The mixture is then placed in a vessel over slow fire and left until it separates into two parts, one as thin as water, the other resembling melted gelatine. The watery part is drawn off, and to the residue is added a solution of 1 pound of mineral salt in 3 pints of water. (Sugar of lead answers very well as the mineral salt.) This brings about another separation of the mass, into a liquid and a mushy solid. The liquid is strained or filtered off, and at this point coloring matter may be added. The solid is now subjected to heavy pressure in molds of any shape, and afterwards dried under great heat. The resulting product may be used in the manufacture of billiard balls, knife handles, or anything for which ebonite or celluloid is adapted.

**LEATHEROID.**—A mixture of American origin, made in black, red and gray, and similar to vulcanized fiber. It is insoluble in ordinary solvents, uninjured by alcohol, ether, ammonia, turpentine, naphtha, or other oils, is very tough, is a good insulator, and is of low cost.

**MARLOID.**—An insulating material said to be made from the hides of certain animals, treated by a chemical process, making it so hard that it can be handled in every way the same as ebonite. It may be transparent or opaque, and is capable of receiving a very high polish. It is said to give an insulation of 2,000 megohms, is unflammable, and is of English origin.

MICANITE.—Mica cemented together under pressure with an India-rubber compound. Manufactured in America.

NIGRITE.—An insulating compound consisting of a mixture of India-rubber and ozocerite.

PANTASOTE.—A cellulose product made by secret processes, largely used in the manufacture of artificial leathers.

PEGAMOID.—This, although covered by several patents, is said also to involve certain secret processes. In a general way, however, the substance is prepared by treating a fine grade of cellulose with a mixture of sulphuric or nitric acid to form nitro-cellulose or gun cotton, which is then dissolved in a suitable alcohol. The Pegamoid patents call for the addition of glycerine, sweet or olive oil, and various coloring matters.

PLASTICON.—See Fibrone.

PLASTITE.—A vulcanite which is made extra hard and is not possessed of any special amount of elasticity. The stock recipe for this is: India-rubber 100 parts, sulphur 25 parts, magnesia 50 parts, orpiment 50 parts, coal tar asphaltum 60 parts. It is very hard and solid, and takes a high degree of smoothness and polish. (Hoffer.)

POTATO CELLULOID.—An Austrian invention relating to an artificial solid produced from potatoes boiled 36 hours in a fluid containing 8 parts of sulphuric acid and 100 parts of water, and then dried. Pipe bowls made from it for the French market are said to be hardly distinguishable from real meerschäum. Billiard balls are also said to be made from it.

PRESSPAHM.—An English insulating material made from wood fiber so treated that it can be run through rolls into sheets of varying thicknesses. It is said to be capable of withstanding high temperatures, and is used not only in connection with electrical machinery, but also for bookbinding and for putting a finish on cloth.

SOREL'S COMPOUND.—A so-called substitute for Gutta-percha consisting of 2 parts resin, 2 parts asphaltum, 8 parts resin oil, 6 parts slaked lime, 3 parts water, 10 parts potter's clay, and 12 parts Gutta-percha. Five per cent. of stearic acid is sometimes added.

STABILIT.—A German invention, the compound for which is

a secret, designed to be half way between hard rubber and vulcanized fiber. It is not affected by corroding substances, and does not absorb moisture. It withstands boiling water where hard rubber and vulcanized fiber do not, and is not attacked by muriatic acid or sulphuric acid.

VEGETALINE.—Cellulose treated with sulphuric acid, dried and ground, then treated with resinate of soda.

VISCOSE.—An English cellulose product, used as a substitute for vulcanite. It may be of any color or any degree of hardness. It has been used in connection with rubber, experimentally, with excellent results. As a friction for belting it is said to be excellent, whether or not the belt has the regulation rubber cover.

VISCOID.—A compound of viscose, formed by mixing with it hot bituminous matter such as tar, pitch dissolved in coal tar, or the like. The resultant mixture, when solidified, constitutes a material of a high insulating character, and is produced at low cost. The bituminous and cellulose matter may be mixed in equal proportions, although there is a wide range of compounds that may be made through the use of various proportions of the substances.

VITRITE.—A jet black, perfectly hard material, having a smooth polished appearance similar to ebonite. It is not affected by dampness or acids. It is a good insulator, is of low cost, and easily worked.

VULCABESTON.—A composition of asbestos and India-rubber, forming a product which is a non-conductor of electricity and stands the severest tests, resisting heat wonderfully. Invented by R. N. Pratt, United States.

VULCANIZED FIBER.—This material, which is very largely used, is made of cotton paper pulp, chemically dissolved, and solidified under enormous pressure. It is unattacked by ordinary solvents such as alcohol, turpentine, ammonia, etc. It appears on the market in two forms—hard and flexible. The hard fiber resembles horn and is exceedingly tough and strong, while the flexible fiber has the appearance of a very close grained leather. It is an insulator in dry places, but, as it will absorb moisture, it is useless in places requiring waterproof



qualities. It is made in three colors—black, red, and gray. Vulcanized fiber is unaffected by oils or fats, and will stand action of hot grease. Low grades have been found adulterated with chloride of zinc and calcium, to the extent of nearly 50 per cent. of its weight.

**WILLOUGHBY SMITH'S GUTTA-PERCHA.**—Gutta-percha refined by a special process invented by Willoughby Smith. Valued in England as giving an increased speed over electrical conductors insulated with it.

**WRAY'S COMPOUND.**—A composition of India-rubber, silica, powdered alum, and Gutta-percha. Used in climates too hot for Gutta-percha by itself. It is easily attacked by seawater.

**XELTON.**—A substitute for hard rubber manufactured principally for use in making battery jars. It originated in Philadelphia.

### III. MISCELLANEOUS SUBSTITUTES AND COMPOUNDS.

**"APO ELASTIKON HYPHASMA."**—An English formula for this is: Take caoutchouc and grind it with a portion of residue from cottonseed oil. Work in as much vegetable fiber as will convert it into a strong felt, adding as much farinaceous matter as will fit it for the finishing roller. The outside husk from rice, finely ground, is preferable. Stearine pitch may be added to give a greater stiffness; also chalk and steatite may be used to harden it.

**ASBESTONIT.**—An asbestos product manufactured in England under a secret process, for use as steam or hot water packing.

**ASTRICTUM.**—A compound to be used in damp places, consisting of pulped cotton 15 pounds, pitch 25 pounds, asphalt 20 pounds, ground granite rock 20 pounds, bitumen 5 pounds, resin 10 pounds, coal tar 12 pounds, and mastic 5 pounds.

**CAOUTCHITE.**—Vulcanized rubber exposed to heat (250° F.) for several days and devulcanized and recovered by this means alone.

**CORK LEATHER.**—A French invention composed of thin sheets of cork, covered on both sides with an extremely thin India-rubber skin, and of a textile fabric outside. It is very light, is a good insulator against heat, and is waterproof.



**BELLEDIN'S PROCESS FOR LEATHER IMPREGNATION.**—Hides are treated in alkaline solutions and immersed in a bath of rubber solution.

**DERMATINE.**—A well known substitute for India-rubber and leather, made of an artificial Gutta-percha called "gum percha," 7 pounds; powdered waste rubber, 7 pounds; India-rubber, 14 pounds; sulphide of antimony, 6 pounds; peroxide of iron, 2 pounds; flour of sulphur, 4 pounds 8 ounces; alum, 4 pounds 8 ounces; asbestos, powder, 2 pounds; sulphuret of zinc, 3 pounds; carbonate of magnesia, 7 pounds. A little change in this compound adapts it for machine belts. A variety of colors is gained by mixing in various pigments in place of sulphuret of antimony or peroxide of iron. The invention is patented by Maxmilian Zingler, of London. It is claimed that Dermatine will stand more wear than either leather or rubber, that it is absolutely unaffected by heat, cold, dryness, or moisture; and that it will stand perfectly the action of grease, oils, or acids. Adaptations of the formula given above permit it to be manufactured in molded forms. It is used for valves, packing, etc., and also for covering insulated wire.

**DURATE.**—An artificial rubber compound said to be similar to Dermatine.

**EKERT'S HIGH PRESSURE COMPOSITIONS.**—Consist of rubber, asbestos fiber, litharge and sulphur. To this base are added oxide of zinc, iron oxide, graphite, magnesium silicate and resin. It is patented.

**ENDURITE.**—The invention of John Stuart Campbell, of England. The basis of it is rubber and it is used in golf balls, belting, etc.

**FIBRINE-CHRISTIA GUM** is manufactured just as Christia gum is, except that silk fibers are used in the place of hemp.

**FROST RUBBER.**—Another name for what is practically sponge rubber made from any ordinary unvulcanized rubber compound by the addition of a little alum or carbonate of ammonia.

**GRONT AND MOORE'S REPAIR CEMENT.**—A mixture of unvulcanized stamp rubber in benzine solution to which are added turpentine and collodion.

**HARMER'S SUBSTITUTE.**—Composed of 150 pounds waste

rubber, 50 pounds Pontianak, 8 pounds African flake, 10 pounds Substitute. Patented.

HEVEENOID.—This is claimed to be more insoluble, durable, and pliable than almost any other rubber composition. Soft Heveenoid consists of India-rubber 32 parts, camphor 32 parts, lime 1 part, and sulphur 8 parts. Hard Heveenoid is made of India-rubber 6 parts, camphor 4 parts, glycerine 1 part, and sulphur 16 parts. Heveenoid is the invention of Henry Gerner, of New York, and is patented in the United States and Europe. Kauri gum is also used in certain Heveenoid compositions. One special advantage claimed as to the use of camphor is that the chemical compound termed sulphide of camphor is produced, and therefore the rubber does not bloom.

HEVEENITE.—Another name for Heveenoid.

INDIA-RUBBER LEATHER.—A compound produced by Nelson Goodyear in which fibrous substances were mixed with India-rubber to form a body the surface of which resembles leather.

IRESON'S PACKING COMPOUND consists of a mixture of rubber, ultramarine blue, and silicate of magnesia.

JACKSON'S COMPOUND FOR PRINTERS' ROLLS.—Sixteen pounds glue, 16 pounds glycerine, 1 pound borax, 1 pound japan.

JOHNSTONE'S NON-DRYING COMPOUND consists of Gutta-percha, resin and carnauba wax.

JUST'S ACID PROOF COMPOSITION is composed of linseed oil, Gutta-percha, sulphur, rosin, shellac, and asphaltum or pitch.

KAMPTULICON.—An India-rubber compound for floor coverings. The simplest English formula is a vegetable fibrous material ground into a coarse powder, mixed with India-rubber, and treated with a cheap solvent, such as coal tar or naphtha. Coloring matters are added, if desired. Another Kamptulicon compound is: Gutta-percha, cheap grade, 6 pounds; reclaimed rubber, 12 pounds; residuum from distilling palm oil, 6 pounds; ground cork, 4 pounds; ground chalk, 2 pounds; sulphur, 6 pounds; hair, 1 pound; oxide of zinc, 1 pound.

KIRRAGE COMPOUND.—A well-known English patented compound, which takes its name from the inventor. It comes in two forms. The first, to be used not over 200° F., is composed of India-rubber 12 pounds, Gutta-percha 4 pounds, Stockholm tar

25 pounds, chalk 60 pounds, hemp 4 pounds, and sulphur 10 pounds. The same inventor also recommends the following, to withstand a great heat and pressure: India-rubber 20 pounds, tar 25 pounds, coke, finely powdered, 25 pounds; Stourbridge clay 25 pounds, sulphur 10 pounds, fine emery 25 pounds, and steel filings 5 pounds.

LEATHERINE is a compound that closely approaches Dermatine, and in fact a part of the first patent on that product. It is intended as a substitute for leather cloth and is made as follows: India-rubber 28 pounds, substitute 10 pounds, sulphuret of antimony 13 pounds, peroxide of iron 4 pounds, sulphur 3 pounds, sulphuret of zinc 10 pounds, carbonate of magnesia 23 pounds, and sulphate baryta 8 pounds.

LEATHERUBBER COMPOUND.—Made of ground waste rubber leather and reclaimed rubber. Manufactured largely in Australia.

LEONARD'S SUBSTITUTE.—Consists of a mixture of corn oil, castor oil, chloride of sulphur, naphtha, and oxide of magnesia.

LUFT'S CELLULOID RUBBER.—By boiling equal parts of phenol and 50 per cent. formaldehyde with sulphuric acid and to the washed and dried product adding India-rubber, a compound is formed that boiled in alkaline solutions is transparent and similar to celluloid.

LIMEITE.—A cement that is manufactured from melted India-rubber, with the addition of 8 per cent. of tallow, with sufficient slaked lime to give it the consistency of soft paste. The addition of 20 per cent. vermilion causes the mass to harden immediately.

MADANITE.—A binding material for smooth surfaces, such as air-pumps, etc., made of 2 parts by weight of vaseline, and 1 part India-rubber, melted. This mixture may be left for years without perceptible alteration. A low grade gum used in the same way in connection with vaseline makes an excellent insulating tape, and has also been used as a friction gum.

METALINED RUBBER.—A name used for compounds used in dental work, under a process patented by C. S. Leadbetter, Manchester, England, for strengthening the gum with a metallic fabric, woven or knit.

MOROCCOLINE.—An imitation leather made from a secret

compound which presumably has India-rubber for its base. Made in various colors but chiefly as an imitation of Morocco leather.

OKONITE.—A well-known compound for insulating wires and cables. According to an English analyst, it consists of India-rubber, 49.6 per cent.; sulphur 5.3 per cent.; lampblack, 3.2 per cent.; zinc oxide, 15.5 per cent.; litharge, 26.3 per cent.; and silica, 0.1 per cent.

PANTASOTE.—A secret compound, probably of oxidized oil, which is used for the manufacture of artificial leather coverings for furniture, bookbindings, etc.

PEDRYOID.—A rubber-like finish for cloth, made presumably of oil, in tan, brown, olive, and other colors, and used chiefly in shoe finishing.

RATHITE.—A mixture in which waste silk fibers are incorporated with India-rubber to impart resiliency and durability. About 6 ounces of silk are used with 28 pounds of rubber compound. It is employed in making tires, pump valves, packings, etc. Patented by A. I. Rath, Cheshire, England.

RUBBERIC.—Fiber blended with India-rubber in solution, stretched, and dried. Used chiefly in making rubber tires and mechanical rubber goods. Patented by William Golding, Manchester, England.

RUBBER ASPHALTE.—For road making, a late French patent covers a mixture of rubber and asphalt, that after intimate mixture takes the form of a powder. This is laid hot and under test is very cheap and lasting.

RUBBER VELVET.—Manufactured by sprinkling powdered felt of a variety of colors over proofed cloth before vulcanization. The result is a velvet-like fabric, elastic and waterproof.

THESKELON CEMENT.—A metallic substance used for waterproofing and for certain kinds of packings. It will neither expand, contract, nor rust. It is used instead of wax for sealing purposes, and resists acids, alkalies, and grease. It is often used in place of asphaltum. It can be mixed with tar, pitch, asphaltum, and other similar ingredients, the compound possessing extraordinary adhesive power. Patented by Thomas Smith, London.

TURNBULL'S ANTI-FOULING RUBBER PAINT.—Pitch and resin are melted together, and then a mixture consisting of crude

naphtha, dissolved Para rubber, and sifter whiting is added thereto.

UNVULCANIZED PACKING WASHERS.—Goldstein claims in an English patent a washer material for the sheet-metal lids of vessels is made, without containing sulphur, of a mixture of crude rubber, talc, asbestos, and Gutta-percha.

VOLTAX.—An American insulating compound not subject to chemical change, and proof against water, acids, and alkalies. Is cheaper than rubber and does not affect copper—hence tinning of the wires is not necessary.

VULCANINA.—A preparation of rubber, a Brazilian invention, for paving.

VULCANINE.—A mixture of India-rubber, asbestos, litharge, lime, and powdered zinc, to which is added a percentage of sulphur. Mentioned in a patent granted to J. E. Hopkinson, West Drayton, England.

WHALEITE.—See Woodite.

WOODITE.—A name suggested by Sir E. J. Reed for an India-rubber compound invented by Mrs. A. M. Wood. It is said to possess the elasticity of India-rubber, to be unflammable, and not injured by salt water. It is used in making valves, packings, etc. It is claimed that it will not become sticky or soft under heat or steam pressure, and will stand hot grease and other lubricants, and neither acids, alkalies, nor wastes from oil refineries, distilleries, etc., affect it in the least. A compound for Woodite or Whaleite packing is: Asbestos fiber 38 pounds, asbestos powder 38 pounds, earth wax 6 pounds, charcoal finely ground 9 pounds, ground whalebone 20 pounds, Para rubber 80 pounds, and sulphur 5 pounds.

ZINSSER'S BARREL LINING.—A compound for lining casks, consisting of deodorized copal, rosin, India-rubber, and a non-drying fat, with coloring matter, such as asphalt.

#### IV. MINERAL RUBBERS.

GENASCO HYDRO-CARBON.—A product made from high grade asphalt so treated that it is valuable in rubber compounding.

KAPAK.—A product made from treated elaterite. Used in general rubber compounding.



LABELLE'S MINERAL RUBBER.—A treated elaterite produced by an inventor in Utah.

"M R".—A product of a semi-elastic material similar to elaterite which by chemical treatment is made stable and tractable. It is wholly neutral, is free from sulphur and acids, and does not vaporize under heat. Is largely used in rubber compounding.

PIONEER MINERAL RUBBER.—One of the first successful asphaltum rubbers used in connection with rubber compounding. It unites perfectly with any grade of crude rubber or with reclaimed rubber. Is said to prevent blistering, and to minimize the harsh action of free sulphur; is acid proof.

SARCO.—A rubber assistant, probably made from treated elaterite.

TABBYITE.—A mineral product from Utah which seems to be a mixture of asphalt and paraffine oils. It is easily manipulated and quite elastic.

#### V. PUNCTURE FLUIDS AND FILLERS.

CYCO is a popular compound, said to serve as a preserver of tires as well as healer of tire wounds. It is made of vegetable gums that will not harden; neither will it interfere with vulcanizing in the event of a large rupture.

DOW'S INNER TUBE FILLER.—A mixture of paste and feathers held in a continuous pocket that covers the tread of the inner tube.

ELASTES.—An English compound made of glue, glycerine, and chromic salts.

EVERLASTIC is a substitute for air, and by some considered a good compound. As a liquid it is forced into the tire until the desired pressure is reached, and in a comparatively short time it solidifies and is said to become like rubber. It is not affected by heat or cold.

FAGIOLI, under a British patent, produces a composition consisting preferably of these proportions: 1 pint giant cement, 1½ pints of rubber solution, and 2½ gallons granulated cork.

FRANKENBURG'S PUNCTURE FLUID.—Made of dead Borneo, oxidizable vegetable oil, and sulphur; a British patent.

INRIG, under a British patent, prepares a rubber substitute from the gelable portions of animals. Fifty parts of such ma-

terial are treated with 50 parts of water and from 20 to 60 parts of oil at a temperature of 200° F. Subsequently sodium stannate and potassium bichromate are added. On heating to 212° F. a mass is obtained which may be set in a mold and used for filling motor tires.

NEWMASTIC.—A tire filler, the component parts of which are a secret, but which is apparently of the glue and glycerine type.

PUNCTURE CLOSER.—A British compound: 10 parts Gutta-percha, 60 virgin wax, 5 tallow, 20 rosin, 5 wild thyme.

ROLAND'S PUNCTURE COMPOUND.—A glue and glycerine to which is added sugar or molasses.

RUBBERINE.—A tire filler that is pumped in liquid form into the tire and solidifies into a semi-resilient mass. Of English origin.

SCOTT'S PUNCTURE FLUID.—Fifty parts milk, 17 parts isinglass, 200 parts gelatine, 10 parts Carnauba wax, 3 parts formaldehyde, 1 part gum ammoniacum. Of British origin.

SUBER'S FILLER.—One ounce Carnauba wax,  $\frac{1}{2}$  ounce gum tragacanth,  $\frac{1}{2}$  ounce water. Add glue and mix in steam.

TIRE LIFE.—A tire filler of the glue and glycerine kind.

## VI. CELLULOID AND CELLULOSE PRODUCTS.

CELLULOID is made in the main from camphor and nitro-cellulose in alcohol, ether being sometimes employed as an additional solvent. The paste formed in this way is warmed gently, and then rolled out into thin sheets. The product is a brittle horny mass, consisting of a chemical, or at least an intimate, mixture of camphor and pyroxyline. A great variety of coloring matters may be added to it, and it is susceptible to manipulation and processes whereby it has been made quite flexible and practically incombustible. Crude celluloid has a specific gravity varying between 1.25 and 1.45, and has a strong odor of camphor.

CELLIT.—A cellulose acetate. The invention of a German chemist, designed to take the place of celluloid, but to be more easily worked and safer by varying the organic substance that takes the place of camphor. A great variety of products

is produced. The substance varies from a soft plastic to a hard product according to the degree of compound used.

CELLULITH.—A cellulose substitute said to be an improvement on viscoïd. Mixes readily with shellac, rubber, etc.

CELLULOSE is a pure substance forming the cellular tissue of plants. In the arts use is made generally of cotton or filter paper which has been treated with acids to dissolve out impurities, and forms a basis for the manufacture of celluloid, gun cotton, pyroxoline, and xylonite. On analysis it shows: Carbon 44.44, hydrogen 6.18, oxygen 49.38. It is dissolved in sulphuric acid, and is converted into dextrine, and, by prolonging the action, into glucose. So far it has not been used largely in rubber compounding, but both alone and in connection with various other ingredients has been applied as a waterproofing. It is the basis of certain Swiss puncture fluids.

GALALITH.—A German product from casein. The process roughly is to make the casein insoluble by the addition of salts and acids. The product is then dephlegmated and dried, when, by the addition of formaldehyde Galalith is obtained. The process is protected by numerous patents.

GUN COTTON.—Prepared by treating cotton wool with a mixture of strong sulphuric and nitric acids, or nitrate of potash may be substituted for nitric acid. After treatment with acid the Gun Cotton is rinsed carefully in cold running water, and then dried by pressure or by exposure to the air. All acid should be removed to prevent danger of explosion. Gun Cotton has been used to render fabrics waterproof, for varnishing India-rubber to render it impervious to gases, and in insulation work. Alexander Parkes, as far back as 1855, used a solution of Gun Cotton with gums or resins to take the place of compounds of India-rubber. He rendered Gun Cotton less inflammable by using biphosphate of ammonia, magnesia, talc, alum, or similar substances. As a good solvent for Gun Cotton, he distilled in 1 gallon of naphtha from 2 to 6 pounds of chloride of calcium. Charles Macintosh used as a solvent equal parts of wood spirit and coal tar naphtha.

NITRO-CELLULOSE.—This is produced by the action upon cellulose of nitric acid or a mixture of nitric and sulphuric acids.

According to the length of time the acid is allowed to act, the resulting Nitro-Cellulose contains 53.7, 43.6, 36.7, or 28 per cent. of nitric acid (nitric-anhydride). Gun cotton is usually a mixture containing higher percentages while Pyroxyline—or, as it is sometimes called, soluble cotton—is a mixture of lower compounds. The solution of pyroxyline in a mixture of alcohol and ether is called Collodion.

**PYROXYLINE.**—A species of gun cotton less explosive in its qualities, prepared from cellulose by means of nitro-sulphuric acid. Its solution in a mixture of ether and alcohol is called Collodion.

**TEXODERM.**—An imitation leather with a hard durable water-proof surface. Basis of which is cellulose.

**WEBER'S CELLULOSE COMPOUND.**—Ten pounds of cellulose steeped in a 20 per cent. solution of caustic soda and allowed to stand for ten hours; then pressed until its weight is 35 pounds; then treated with 8 pounds cold carbon bi-sulphide for three hours; then emulsified with a mixture of 40 pounds Pontianak gum, 15 pounds mineral oil, and 10 pounds stearine pitch.

**XYLONITE.**—See Celluloid.



## CHAPTER VII.

### RECLAIMED RUBBER AND ITS USES.

RECLAIMED rubber, known also as recovered or regenerated rubber, shoddy, and crumb, is produced from worn-out rubber goods. There are two general methods in vogue, known respectively as the mechanical and the chemical processes. Where the mechanical process is followed, the waste is ground to a fine powder, which is run over magnets to extract the iron, and is then put through a blowing process, which separates the woolen or cotton fibers from the rubber. The rubber powder is then subjected to a high degree of heat (the process known as devulcanization), and afterwards sheeted, when it is similar to unvulcanized compounded rubber.

The chemical process is similar to the mechanical, except that the fiber is destroyed by means of acid or alkaline solutions and quite a percentage of it is washed out with the residue after the process is finished. Special grades of reclaimed rubber are made from mechanical goods that have high grade frictions in them and also from unvulcanized scrap. Rubber is also reclaimed from ordinary mechanical goods, such as hose, belting, and packing, and for certain purposes is mixed with what is known as shoe shoddy. White scrap, from wringer rolls, tubing, druggists' sundries, and the like is also produced. The great trouble with the white is that, on second vulcanization, it is apt to be very hard. At one time, hard rubber dust was to be found in the market and was used as a shoddy in certain grades of vulcanite. There is to-day but very little of it to be found, however, as most of the manufacturers of hard rubber goods find a use for all that they make.

The processes followed in the reclaiming of waste rubber are no longer secret. Those who are in the business of manufacturing for the trade are able to do it as a rule because they buy waste stock at a lower figure than a small user could, besides which, by manufacturing the goods in large quantities, they can do it more economically than it could be done in a small way. In this busi-



ness are used crackers, sheeting mills like ordinary grinders, and, indeed, general machinery not dissimilar to that used in a mill where crude rubber is compounded. They have in addition, however, lead lined tanks for acid treatment, vulcanizers or, better, devulcanizers, huge vats for washing, magnets for removing metal, sieves, and the like. This branch of the rubber business is not supposed to be deeply interested in compounding, in spite of the fact that it is sometimes suggested that earthy matters and heavy adulterants do find a use in reclaiming mills.

Rubber scrap of any sort, vulcanized or unvulcanized, is eagerly sought for reclaiming, the world over. The larger factories use their own scrap of both kinds, yet much unvulcanized scrap gets upon the market chiefly in the form of Para cable strippings, mackintosh cloth cuttings, frictional fabric, and cement ball.

Next to this in value, and indeed often more valuable is the pure gum vulcanized scrap, such as rubber thread, and a variety of floating stocks that do not contain rubber substitutes. Special high grade stocks such as billiard cushions, balloon fabrics, etc., are favorites in this line.

The greatest single item in scrap collection, is, of course, old rubber boots and shoes. They are graded roughly by the country of their origin—American, English, German, Russian and so on—and their conversion into workable rubber has long been the backbone of the reclaiming business.

Most of the products of the mechanical goods factory come into the market as waste eventually, and are sorted and graded according to the richness of the compound, and the freedom from metal and fabric. In this line is the red scrap such as valves, the drab embracing wringer rolls, mattings, buffers, and hose graded as air brake, fire hose linings, and garden hose. Then there is the grading of belting, asbestos scrap, red and other packing, etc.

In tires there is the collection and sorting of solid tires into cab, baby carriage, omnibus tires. In pneumatics, there are single and double tube bicycle tires, motor cycle casing and automobile tire shoes—American, French, and German. There is also the inner tube in gray, red, and green that is to-day a large factor in the recovery business.

In druggists' sundries, water-bottles, and the like furnish white rubber. Tobacco pouches, red rubber, while air and water beds, sponges and many other specialties furnish regular grades.

In hard rubber, cells, telephone receivers, sheets and rods are ground up and used again, while hard rubber shavings and dust find a ready market.

Gutta-percha in the form of cable strippings, balls, and buckets is a type of waste with a recognized place. And these are but a few of the many grades put out by the sorters, and sold to the scores of reclaiming plants the world over, that turn out the two hundred or more millions of pounds of usable rubber from what was once thrown away or burned under the factory boilers.

Almost the first attempt at recovering rubber waste was that done at the Beverly Rubber Works, in Massachusetts, back in the fifties, when Hiram L. Hall boiled waste vulcanized rubber in water, after reducing it to a powder, and then sheeted it. It is a curious fact that, in one little mill to-day, the manufacturer grinds his own scrap, boils it in hot water until it is in condition to sheet, and makes a fair article out of it.

The year after Hall's patent, another was granted to Francis Baschnagel, who paved the way for devulcanization by covering a process whereby a finely ground rubber was exposed to the action of live steam. It was not, however, until E. H. Clapp took hold of the business and discovered a process for blowing the fiber out of the finely ground rubber prior to its devulcanization that the goods began to be used to a large extent.

The next step in the progress of the art was characterized by the taking out of a great variety of patents, most of which depend upon various acids and alkalies for destroying the fiber. These patents were more than fifty in number, and were fully reviewed with their attendant processes in the famous suits brought by the Chemical Rubber Co. against The Goodyear's Metallic Rubber Shoe Co. and the Raymond Rubber Co. While it would be tedious to go into that matter, it is interesting to touch upon important processes involved. The action of acids upon fibers, of course, had long been known; in connection with the rubber business, however, it was without doubt novel. The Hayward patent, for instance, mixed 75 pounds of sulphuric acid with 8 hogs-

heads of water, and in this way the fiber was weakened so that it was easily ground up with the rubber. The Faure patent called simply for the immersion of the clippings in an acid, which in disintegrating the textile matter set the India-rubber free. Hiram Hall advised the use of lime or alum to eat up the cloth, and also a solution of 1 part of sulphuric acid to 9 parts of water. Burghardt used muriatic acid for destroying the cloth fiber. The Heinzerling patent called for a treatment first with acids, and then with alkalies. It is also to be remembered that Charles Goodyear directed that crude India-rubber should be subjected to a 10 per cent. solution of sulphuric acid to eat up the bark with which the gum might be contaminated.

The Mitchell patents, the Bourn patents, and others, where an extremely dilute acid was used, and where a concentrated acid was called for, have been so thoroughly reviewed that those familiar with the rubber business know all about the processes employed.

What is known as the alkali process, based upon the patents of Arthur Hudson Marks, is one of the notable discoveries in reclaimed rubber in more recent years. Factories for reclaiming under this process are operated in the United States, England, Germany and Belgium, mechanical waste being chiefly used.

In addition to the processes in more general use, a few unusual ones may be interesting. For example, the Tors-trick process, in which dilute nitric acid and fusel oil were mixed with the gum in a heated state, or passed through it in the shape of vapors, making the mass sticky, after which a small quantity of chloride of calcium was added and the gum sheeted.

Conrad Poppenhusen mixed rubber scrap with essential oils, a little turpentine being used preferably, left the scrap until it had become soft, and then passed dry gaseous ammonia into the mass, forming a gelatinous viscid product.

C. F. E. Simond mixed 2 parts of chloride of lime with 100 parts of waste rubber, and brought it to a high degree of heat, by which the sulphur was volatilized, which took from 15 to 60 minutes, and then used the rubber over.

Thomas J. Mayall mixed vegetable tar with waste rubber—exposed it to the heat of the sun, or to a gentle artificial heat, and

got a soft pasty mass that he was able to work with crude rubber. He also invented a process for sprinkling the finely ground rubber with camphene and setting the mass afire in a partially covered vessel, his claim being that if the fire was stopped at a certain point, a tough viscid mass was the result, which contained neither sulphur nor fiber, and could be reworked like unvulcanized rubber.

Beylikgy exposed vulcanized rubber for a number of days to a temperature of 250° F., after which he claimed that it became an adhesive mass, insoluble in alcohol, partially soluble in ether, and wholly soluble in benzole. He called this caoutchoucite and claimed that it could be vulcanized with the addition of sulphur at a lower temperature than ordinary crude rubber.

McCartney, of Glasgow, mixed vulcanized rubber with naphtha and a little acetic acid. He also added camphor, and by the action of heat produced in reality a rubber paint.

The following are briefs of some of the later claims of inventors in rubber vulcanizing:

Anderson's process (English). Ground scrap is mixed with calcium sulphide and coal tar naphtha, exposed to heat, and thoroughly washed.

Alexander's process relates to the production of India-rubber latex from rubber waste. The waste is heated under pressure in benzine. The dissolved matter is then removed, and the solution is heated again in sodium hydrate. The benzine is distilled off and the aqueous solution of caoutchouc filtered and precipitated with acid.

Basle process. A Swiss process which covers the use of various ethers boiling at a temperature of about 100° C.

Brimmer's process (German) consists of mixing ground scrap with *Ricinus* oil, heating until dissolved, adding alcohol for precipitation and washing with a weak solution of caustic soda.

Clift's process (English). Waste rubber is dissolved in a base of the pyridin group, then treated with acid in the presence of a volatile solvent for the separation of the rubber from the base then separating the solvent with the rubber in solution.

Chautard process (French) uses commercial phenol for reclaiming, the phenol being later distilled off. The whole process is quite intricate.

Durvez process (Belgian). Rubber waste boiled with water and finely powdered lime. Product is washed, rolled, and dried.

Eves's process (American). Devulcanizing by treating with sodium sulfate in the presence of heat, then incorporating barium chloride.

French process. Waste vulcanized rubber is heated with terpin hydrate, the mixture is then treated with boiling water, and from the residue the regenerated caoutchouc is extracted by means of a suitable solvent such as commercial xylol. The terpin hydrate is recovered for use over again by cooling the hot aqueous wash-liquors.

French process. The finely divided rubber is heated, preferably at 110° to 180 ° C., under pressure, with a soap solution, to which may be added other substances such as aliphatic or aromatic hydrocarbons, oil of turpentine or the like, and salts capable of forming solutions which dissolve sulphur, such as alkali sulphides, alkali sulphites, etc.

Gilbert-Besaw process (American). This process is not patented, but is secret. It is applicable to the recovery of any sort of rubber scrap, whether cured in open steam, in molds, or in dry heat. According to the statement of the inventors, no acid or alkali, or anything that can be in any way injurious, is added. The machinery for treating the waste rubber for the removal of fiber and for devulcanization is individual to the process. The time occupied in devulcanization is about one-quarter that used in existing processes. No residuum or oily matter of any sort is added to the product, either before or after devulcanization. The results of this process for insulation purposes, in reducing the acetone test, is of itself invaluable.

Gregory and Thom's process (English). Reclaimed in the usual way; then add a solvent which is a mixture of aniline oil and naphtha. The product is heated in open steam until the solution of rubber is complete, when it is taken out and strained.

Gubbin's process (English). Unvulcanized scrap in which the fabric is saturated with naphtha and passed through plain pressure rolls to remove the rubber from the fabric.

Heinzerling's process (German). Ground waste rubber treated with aniline or their homologues at 140° to 180° C. The



rubber is then mechanically separated from the residue; is treated with dilute sulphuric acid, and the separating rubber is washed and dried.

Heyl-Dia's process. Heats ground rubber under moderate pressure in naphtha, temperature being not more than 120° F. The naphtha is then drawn off and with it most of the sulphur. The rubber is then heated to over 350° F. with a fresh solvent when it dissolves. The solvent is then removed and the sulphur washed and dried.

Hyatt and Penn's process. Waste rubber finely ground is put into a vacuum chamber and molded into goods under heat.

Karavodine's process (French) consists of pulverizing the material, adding asbestos fibers which have been previously treated with a binding medium, and subjecting the mass to a higher pressure at higher temperature.

Kessler's process. Waste rubber is treated with carbolic acid in a vacuum. After solution powdered acetate of lead is added and the whole submitted to distillation. Caustic soda is used later for neutralizing.

Kittel's compound (Austrian). Powdered waste mixed with caustic alkalies is compressed into cakes and heated 2 or 3 hours at 280° C.

Koneman's process (American). Ground waste is boiled in a salted-acid solution, and a mixable fixed hydrocarbon is then added.

Koener's process (German). Waste rubber is heated with solvents such as benzine for a time, after which the solution is further heated with water and the solvent subsequently distilled off.

Marks's process (American). Waste rubber finely ground is heated in a dilute alkaline solution in a closed vessel for a time and at a temperature dependent upon the amount of sulphur present.

Murphy's process (American) uses for devulcanizing, a bath consisting of carbonate of soda and gallic acid.

Neilson's process (German). The inventor uses resin oil as a solvent, filters and precipitates the rubber by means of a ketone.

Passmore's process dissolves vulcanized waste with eucalyptol and removes mineral matters by filtrating. The eucalyptol is driven off by having steam forced through the mass.

Penther's process (German). A devulcanizing machine of German origin makes what is known as American reclaimed rubber. It separates the fiber from the rubber so thoroughly that the fluff is a merchantable product in the felt trade.

Peterson's process (American) consists in subjecting shredded waste to an alkaline solution raised to a boiling temperature under hydraulic pressure, next washing in water solution containing phenol under a high temperature and pressure.

Price's process (American) uses caustic solutions of marked strength, under ordinary atmospheric pressure.

Price's process (English). A process whereby waste rubber cut into pieces of suitable size is roughly mixed with crude rubber and ground flint, and without being vulcanized, by great pressure molded into finished goods.

Roux process (French). The inventor describes a machine which devulcanizes powdered waste rubber and makes it into tubing at the same time. In other words it is a combination of a devulcanizer and tubing machine.

Steenstrup's process. The waste is heated in a solution of alkali and hydrofluoric acid under steam. The product is then washed, dried, etc.

Theilgaard's process (Denmark). The inventor has several patents which cover the treatment of vulcanized scrap by alkaline earths and such solvents as sodium sulphide.

Wheeler's process (American) consists in subjecting the waste particles individually to a current of heated fluid moving through a confined passage.

Zuhl's process (English). Vulcanized waste is dissolved in five times its weight of naphthalene at a low temperature. The naphthalent is then distilled from the mixture with same.

## CHAPTER VIII.

### RESINS, BALSAMS, GUMS, EARTH WAXES, AND GUM-LIKE SUBSTANCES USED IN RUBBER COMPOUNDING.

A GREAT variety of vegetable, mineral, and animal resins and waxes find uses in admixture with India-rubber and Gutta-percha. Their important uses are to render compounds adhesive, as in frictions, to assist in insulation, to add luster, and to modify the texture of the vulcanized compound. Many gums, like many earths, lend special virtues which they possess to rubber compounds. The more important of these materials, and those most generally used, are described in the following pages.

ADAMANTA RESIN.—An imitation copal, manufactured from common resin by a special hardening process. It is not soluble in alcohol or benzine, but completely so in boiling turpentine. It is free from acids and alkalies, and has the same melting point as Zanzibar copal. It is used rarely in rubber shoe varnish, and often in cheap frictions in mechanical lines, being moistened with resin oil to increase its adhesiveness.

AMBER.—A fossil resin chiefly found in Prussia, on the shores of the Baltic sea; it occurs also in Sicily and sometimes in the United States. It is the hardest and heaviest of the resins. Its specific gravity is about 1.07. By distillation a yellow oil—oleum succini or oil of amber—is obtained, and a yellow resin remains in the still. Amber varies in color from light yellow to a deep brownish red. It is insoluble in almost all of the ordinary solvents. When heated above its melting point, however, it becomes partly decomposed, and is then soluble in oil of turpentine and alcohol. It makes a very fine transparent varnish, which is used on negatives in photographing. It is used in cements for fastening linoleum and rubber tiling to decks, and is also mentioned in the formulas for certain patented gums.

ASPHALT is undoubtedly an oxidized residue from evapor-

ated petroleum. This name is applied usually to the solid bitumen, the liquid being called mineral tar, and sometimes maltha. It is chiefly made up of hydrocarbons, but contains a certain amount of sulphur and nitrogenous bodies. It is known also as natural pitch, Jews' pitch, asphaltum, bitumen, etc. It is a black hard substance which, when freshly broken, shows shining surfaces that are always correspondingly rounding and hollowing. It is insoluble in water and alcohol, but dissolves in benzine, acetone, and carbon disulphide. Is used in rubber compounding in place of coal tar, and in insulating compositions, and in certain substitutes like Kerite. Commercially there are two grades, known as "lake pitch" and "land pitch," of which the latter is the harder.

In solution it is used sometimes to protect rubber goods that are exposed to the destructive influence of brine. A little Asphalt is also said to increase the elasticity of hard rubber. Asphalt mixed with resin and oil of tar forms a low grade artificial Gutta-percha. It is added to "Cooley's artificial leather" to harden it and enable it to resist heat. It is also the basis of one type of marine glue.

**ARTIFICIAL ASPHALT.**—This is made by heating sulphur and resin together to about 250° C., where the reaction takes place, attended by the evolution of sulphuret and hydrogen, and leaving an almost black, pitchy substance resembling asphalt. It is insoluble in alcohol, but dissolves readily in benzine.

**AUVERGNE BITUMEN.**—A species of natural asphalt found in the province of Auvergne, France. It is similar to Trinidad asphalt, but is impure, containing clay, silica, magnesia, iron, and traces of arsenic. (See Asphalt.)

**BALSAM.**—This term is given to oleo resins which are soft at ordinary temperatures, and are really a mixture of such a resin and the essential oil of the plant from which they exude, such as benzoin, tolu, etc.

**BALSAM OF STORAX.**—Produced from the inner bark of a tree of the genus *Storax*, in Asia Minor. Commercially it is a soft, coarse, dark colored powder, or, more commonly, a semi-fluid, adhesive substance, brown outside, greenish gray



inside. The sweet gum of the southern United States is allied to the Eastern drug, and was formerly much used in chewing gum. Used in general cements, being particularly good in leather cements; also for glass, stone, and earthenware cements.

**BALSAM OF SULPHUR.**—A solution of sulphur in boiling volatile or olive oil. Used in certain rubber compounds as a vulcanizing agent and a protection against blooming.

**BEESWAX** is obtained from the comb built by honey bees. The crude wax is yellow and soft, with a granular fracture. Its specific gravity varies between .965 and .969, its melting point being between 140° and 144° F. It is often adulterated by water, by white mineral powders, and by cheaper substances, such as vegetable wax, paraffine, etc. White wax is that which has been exposed to the sun or to the moderate action of nitric or chromic acid, thereby being bleached. It is sometimes used with rubber in medicinal plasters. Ordinary beeswax is largely used in Kiel's hard rubber compounds. Sheet beeswax is often used in the work of vulcanite pattern making. It is also used in processes for making fabrics water-repellent, the other ingredients being aluminum, resin, soap, wax, and silicate of soda. With Gutta-percha it is an ingredient in shoemakers' wax, and also in certain proofing compounds. Hancock used it in a Gutta-percha compound for a soft effect. In a hard rubber compound made up of India-rubber, sulphur, oil, and pumice stone, it is said to be acid proof.

**BIRCH-BARK TAR.**—A peculiar tar obtained during the distillation of birch-bark for oil, being probably the same as Russian Jackten extract. Used in the manufacture of certain rubber substitutes.

**BITUMEN.**—The term applied to a body made up of several hydrocarbons. It resembles Trinidad asphalt and is of the same nature. Its specific gravity is from 1.073 to 1.160. Artificially it is prepared from shales, mineral asphalt, etc. It is used as a source of paraffine. The West Indian product is known as Chapapote. A solution is made from it in which the tapes are soaked that are used for covering wire that has



been insulated with India-rubber. Bitumen has been utilized by what is known as the calender process, which is a partial vulcanization, rendering it valuable as an insulator.

**BLACK PITCH.**—Is the residue left after the oils of tar have been distilled from that body. Used in weather proofing work.

**BRITISH GUM.**—See Dextrine.

**BURGUNDY PITCH.**—Is obtained from the hardened juice or sap which concretes upon the bark of the Norway spruce. As imported it is often quite impure and should be melted and strained before being used. It is almost entirely soluble in glacial acetic acid or boiling alcohol, and somewhat in cold alcohol. When pure it is hard and brittle, with a shining fracture, dissolves in benzine, acetone, and carbon disulphide. Is used reddish or yellowish-brown, aromatic. It is much used in cements, in electric tape, and in the manufacture of porous plasters. Common resin is often melted and mixed with fats and water, forming a gum that much resembles Burgundy Pitch.

**BURMITE AMBER.**—Found in Burma, but quite inferior in quality. It is a little harder than amber proper, is easily cut, takes an excellent polish, but has less variety of color. (See Amber.)

**BUTTON LAC.**—See Shellac.

**CANADA BALSAM.**—Sometimes called Canada Turpentine. It is derived from the *Abies balsamea*. It is a yellowish or greenish transparent liquid, completely soluble in ether, chloroform, or benzol. It is sometimes called Balsam of Fir, but it does not really belong to the balsams, being a true turpentine. Strasburg turpentine is sometimes substituted for it commercially. It is used in certain compounds to prevent sulphur from efflorescing. With paraffine, beeswax, and coloring matters, it is used for insulating colored yarns that are used for annunciator and similar wires, and it was also used by Duncan in Gutta-percha cements for leather.

**CANDLE TAR.**—The residual products from the distillation of animal fats, oils, etc., are known as candle tar. This product is sometimes soft and ropy, and at other times quite hard.

Mixed with sulphur, it is said to produce a compound having some of the elasticity and other desirable qualities of vulcanized India-rubber.

CASEIN (also called Caseum) is one of the chief constituents of milk, being that part which forms the curd of sour milk, and is familiar in the form of cheese. A similar substance, prepared from peas, beans, lentils, and the like, is called vegetable Casein. It is used in shower-proofing after a German formula in connection with soda, lime, and acetate of alumina; also, in cements of which Gutta-percha is the base, for joining small particles of leather, shavings, etc. In Kittel's compound Casein dried and powdered is mixed with linseed oil. India-rubber or Gutta-percha is then added to the compound. A sample compound is India-rubber 10 parts, Casein 20, superoxide of lead 10, sulphur 3, and linseed oil 1.

CARNAUBA WAX is found in Brazil, where it forms as a coating on the leaves of a certain palm (*Corypha cerifera*), and is removed by pounding and shaking. It is very hard and is of a greenish or grayish color. Its specific gravity is about 0.995, it is odorless, and melts at 185° F. It dissolves completely in boiling alcohol, and is used on insulated wire as a finish, and in the manufacture of wax varnishes.

CARN GUM.—Used instead of ozocerite as a finish for tape or braids that cover insulated wire. (See Carnauba Wax.)

CERAMYL.—A material used in the finishing process in the manufacture of elastic web. Its use is to make the web stronger, and in a measure to act as a size, causing it to lie flat. It is also said to add strength to it. By the application of heat, ceramyl, which comes in the form of a semi-solid, is reduced to a liquid. In English practice this is said to have driven out the use of glue in the dressing of elastic webs. Ceramyl is manufactured in England.

CERASIN, also spelled Ceresine, is of a butter yellow color, odorless, and has a specific gravity of .918 to .922. It is used chiefly in covering annunciator wires where the object is to preserve the colors of the yarns in the braiding. (See Ozocerite.)

CHERRY GUM.—A pale yellow or red brown gum, coming from the bark of old cherry trees. It contains 35 per cent. of

cerasine, 52 parts of arabicum, and 1 to 3 per cent. of ash. This gum is chiefly used in the manufacture and finishing of fine felt hats. The gums on the market are of two qualities, the German, which is the best, and the Italian. It is used in insulating instead of purified ozocerite, in certain cases where a little more adhesiveness is required.

**COALITE PITCH.**—A residue of Coalite tar, much like natural bitumen and containing little free carbon. An English product.

**COAL TAR.**—See Tar.

**COLOPHANE.**—See Rosin.

**COLOPHONY.**—See Rosin.

**COORONGITE.**—The name given to a rubber-like mass found in Coorong, South Australia. Some place it among the fossil resins. Coorongite is not soluble in the ordinary solvents used in rubber work, but, after mixing with India-rubber, it can be put in solution. According to Forster, it vulcanizes somewhat as India-rubber does. (See Psuedo Rubbers.)

**DEXTRINE** is a sort of intermediate product between dextrose and starch. It is soluble in cold water, and is much used as a substitute for gum arabic in mucilage, as it has strong adhesive properties. Cooley combined it with a little Gutta-percha, resin oil, and earthy matters in the production of what he called artificial leather. It is used also in a mixture with plaster of paris, making a tough surface mold for small experimental rubber work.

**DEXTROSE** is obtained from starch generally, and is crystallized glucose. It is soluble in water, and has many commercial uses. For example, it was used by Hancock as a sizing for cloth on which was spread rubber in solution, the Dextrose being there in order to keep the rubber from sticking to the cloth. In other words, this was a sort of cheap calendering process.

**EARTH WAX.**—See Mineral Wax.

**ELATERITE** is also known as elastic bitumen or mineral caoutchouc. It appears naturally in soft, flexible masses of a brownish black color somewhat resembling India-rubber. It is composed of 85.5 per cent. of carbon, and 13.3 per cent. of hydrogen. In its physical characteristics, Elaterite is found in infinite variety. It is sometimes elastic and so soft as to adhere to the fingers, and sometimes brittle and hard. One kind of it, when fresh cut, re-

sembles fine cork, both in texture and color, and will rub out pencil marks. Its elasticity is due to its cellular texture, and to the moisture with which it combines. It is used to a certain extent in insulating compounds, but is intractable and so far shows no special features of value above other minerals of the same series. A few years ago a company was formed in Colorado which claimed to be able to make many kinds of rubber goods from this product alone, but little has been heard of the plan of late. (See Gilsonite.)

ELASTIC GLUE is used with India-rubber and Gutta-percha in shoemakers' cements. (See Substitutes.)

FRENCH ASPHALTE.—See Auvergne Bitumen.

FICHTELIT.—Occurs in a peat bed near Rednitz in the Fichtelgebirge in Germany, and also in fossil pines in the form of scales or flat needles. It has also been met with in Franzenbad and in Denmark. A hydrocarbon little known, though mentioned in certain patented rubber compounds.

FISH GLUE.—Made by boiling the heads, fins, and tails of fish by high heat. It is generally made into a liquid glue by a treatment with acetic or hydrochloric acid, whereby its property of gelatinizing is lost. It would have a disagreeable odor were it not for the fact that that is destroyed by adding cerosite or oil of sassafras or something of that kind. Fish Glue is used in a cement for cured rubber, in connection with Gutta-percha and rubber dissolved in bisulphide of carbon. (See Glue.)

GARNET LAC.—See Shellac.

GILSONITE.—A hydrocarbon valued for its elasticity. One of the purest of crude bitumens, it is mined in the Uncompahgre Indian reservation, Utah, United States. It is a black, tarry-looking substance of brilliant luster. It is used for varnish making, in paints, and for insulation, either with or without rubber, one well-known compound consisting of rubber, linseed oil, and Gilsonite.

GLUCOSE.—The commercial form is prepared from starch usually, as that is the cheapest raw material. The starch paste being boiled with mineral acids, dextrose, maltose, and dextrine are produced. Glucose in this country is made entirely of corn-starch; in Europe, however, sago starch, rice, and potato starch are used. It is neutral, and both odorless and colorless. It is

really a kind of sugar that is with difficulty crystallizable, and it is also called grape sugar. It occurs in commerce either as a thick, sweet, heavy liquid, or as a white solid mass. It is used with rubber, glue, sugar, whiting, and glycerine in making bookbinders' cements, and in making puncture fluids for pneumatic tires.

**GLUE.**—An impure form of gelatine obtained from the horns, hoofs, skins, and bones of animals. Glue of good quality should be bright brown or brown yellow in color, free from specks, glossy, perfectly clear, hard, and brittle, should not become damp by exposure to the air, and should snap or break sharply when being bent, the fracture showing a glassy, shining appearance. Used in bookbinders' cements, in cheap frictions, and in cheap horse-cover compounds with rubber. A size made of glue was used by Brockedon to protect fabrics that come in contact with the liquid used in cold curing. This was afterwards dissolved off by an alkaline solution.

**GLUGLOSS GELATINE.**—A gelatinous product used largely in America in waterproofing fabrics. It is dissolved in hot water to use, and makes an excellent waterproof sizing. A mixture of glycerine with it increases its elasticity. It combines readily with glue, dextrine, or any such products, and develops considerable adhesiveness.

**GLUTEN.**—A vegetable substance obtained from wheat and other grains. Treated with tannic acid, it is used as a substitute for Gutta-percha under a formula by Johnson, who says the product can be vulcanized. Another formula calls for its mixture with oil and sulphur, as a substitute for Gutta-percha. In cements it is the basis of one for uniting leather scraps, and is used with a little Gutta-percha.

**GUM ANIME** is a South American fossil resin similar to copal. It occurs in small irregular pieces of a pale yellow color. Has a high melting point, and its specific gravity is 1.028 to 1.072. Mixed with rubber and earthy matters and dissolved in turpentine, it formed one of the early compounds for clothing.

**GUM ARABIC** is an exudation from a species of *Acacia*. It is made up of clear or semi-transparent fragments, hard and brittle, breaking with shining fracture. It is inodorous and feebly sweetish to the taste. Its specific gravity is 1.31 to 1.52, for dried



gum. It comes from Africa and is known also as Acacia and Gum Senegal. It dissolves in hot or cold water. It is used in connection with plaster of paris in making a tougher surface mold for small and experimental rubber work. Enough gum is added to make the mixing solution about the thickness of a thin syrup. It is largely used in cements. It is also used in certain shower-proof compounds, and in paste blackings made of caoutchouc oil, vinegar, molasses, and boneblack.

GUM AMMONIACUM.—Exclusively obtained from Persia as tears, or aggregated masses, of a peculiar smell and a taste slightly sweetish, bitter, and somewhat acrid. Its specific gravity is 1.207. Used in solutions for pressed leather cuttings and fibrous wastes. Ten parts of this gum mixed with 20 or 25 parts of Gutta-percha form a cement possessing both elasticity and solidity, and is thoroughly waterproof, used for filling cracks in horses' hoofs. Also used with Gutta-percha, boiled linseed oil, and dry casein or caseum, for sticking together small particles of any dry matter in the production of artificial leather.

GUM BENZOIN.—Occurs in lumps of yellowish brown tears, stuck together and more or less mottled from the white inside the tears. Its specific gravity is from 1.063 to 1.092. Of an agreeable balsamic odor and very little taste, but irritating when chewed for some time. Used in linseed oil proofings, presumably to kill odor; also in certain Gutta-percha and India-rubber compounds for disguising the odors. Four per cent. of the weight of the mass is said to be sufficient to make the odor an agreeable one. According to Forster, a little of it mixed with Gutta-percha greatly improves the quality.

GUM ASPHALTUM.—Refined natural bitumen, also called litho-carbon. Is found in Texas and at one time was exploited as a substitute for rubber. (See Litho-Carbon.)

GUM CAMPHOR.—The white transparent substance known by this name is obtained from Japan and the island of Formosa. It is really an oxygenated essential oil. Its specific gravity is 0.985. Sparingly soluble in water, and very soluble in alcohol, ether, acetic acid, and hydrocarbons or volatile oils. Is largely used in the manufacture of celluloid. Gum Camphor is also used in

compounds of the substitute order like Textiloid, Kerite, etc. Was also the basis of the Heevenoid compounds (which see).

**GUM COPAL.**—Hard Copal is a fossil resin obtained from the East Indies, South America, and the eastern and western coasts of Africa. It occurs commercially in roundish, irregular pieces, having a specific gravity of 1.045 to 1.139. It is insoluble in alcohol, partially soluble in ether, and slightly so in oil of turpentine. Soft Copal is obtained from living trees in New Zealand, the Philippine Islands, Java, and Sumatra. Used with shellac, asphaltum, and arsenate of potash for waterproofing leather; also in cements, in proofing compounds, and in varnishes in connection with India-rubber, lead, alum, and other ingredients dissolved in spirits of turpentine.

**GUM DAMMAR** is derived from the Amboyna pine, growing in the Malay peninsula, Sumatra, and Borneo. The resin exudes in tears and is collected after it has dried. It makes a very transparent varnish, the gum being soluble in benzine, essential oils, and to a certain extent in alcohol. Used in artificial leather compounds, and with rubber, asphalt, and fish oil for waterproofing leather. It is quite largely used in rubber cements.

**GUM ELEMI** comes from the Philippine Islands, and is a rosin obtained from certain trees there. It varies from white to gray in color, and is quite soft and very tough. Alcohol and other solvents readily dissolve it, and its office usually is to give toughness to varnishes in which are harder resins. Used in connection with India-rubber and benzine in the production of puncture fluids. (See Manila Gum.)

**GUM EUPHORBIIUM** appears in the market in the shape of tears of irregular shape, varying in size from a small pea to  $1\frac{1}{2}$  inches in length. Of a dirty gray or yellowish color, and very largely mixed with impurities. Must not be confused with Gum Euphorbia (which see).

**GUM FRANKINCENSE.**—Also called Olibanum (which see).

**GUM GAMBOGE.**—The best is found in commerce in cylindrical rolls of a dull orange red color. Another form is that of lumps or cakes. Its powder is bright yellow and its taste very acrid, but it has no smell. It is derived from a tree which is a native of Cochin China and Siam. Is used chiefly as a pigment.

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It is the basis of a general cement in which are also found rubber, alum, and burnt sugar, and in another is used with rubber, white lead, gum benzoin, alum, sugar, and sulphur, for cementing vulcanized rubber.

**GUM LINI.**—A gum made from linseed, often used as a substitute for gum arabic. The seeds are first boiled in water for an hour, the resulting thick mass filtered, and then treated with twice its volume of 90 per cent. spirits of wine. A flocculent white precipitate separates, from which the dilute spirit can readily be decanted. The gum is clear, gray brown, fragile, and dissolves in water. Two grams in 30 grams of oil is almost identical with an emulsion of gum arabic. In connection with coloring matters is the basis for the Knowlton patented waterproofing process.

**GUM TRAGACANTH** is an exudation which comes in the form of translucent plates of a dull white, which water swells and partly dissolves. It is often used in mucilage in place of gum arabic. The gum comes from the Levant from the *Astragalus gummifera*. Has been used in connection with Gutta-percha for making dental plates that are soft and adhesive to the membranes and that will not rot or deteriorate.

**GUM LAC.**—See Shellac.

**GUM TRAGASOL.**—This is a gum produced from the kernels of the *Ceratonia siliqua*. The use of this gum as a solvent for India-rubber, Gutta-percha, or celluloid has been patented in England. A mixture of 25 parts of dissolved India-rubber, 75 parts of strong gum solution, with the addition of 1 part of carbolic acid to 500 parts of the mixture, makes a cement for wood, and a preservative paint against insects and vermin.

**GUM JUNIPER** is the gum known as Sandarac, obtained from an evergreen growing in northern Africa. It occurs in small, light-colored grains, with a slightly bitter taste. It is soluble in turpentine oil and alcohol. Is used as an assistant in making peroxide substitutes. Mixed with rubber and earthy matters and dissolved in turpentine, it was one of the early compounds for clothing.

**GUM OLIBANUM.**—The frankincense of the ancients, obtained chiefly from Asia and Africa. It occurs in yellowish, somewhat translucent tears, with a balsam-like resinous smell,

and an acrid aromatic taste. Sometimes called Gum Thus. It is largely used in the manufacture of porous plasters.

**GUM THUS.**—A name for gum turpentine, and rarely for olibanum. Used with rubber and Japan for waterproofing leather.

**GUM TURPENTINE.**—Turpentine hardened by exposure to the air. (See Turpentine.)

**HELENITE.**—Another name for fossil rubber or Elaterite (which see).

**ISINGLASS.**—A substance prepared from the swimming bladders of certain fish. It is white and glistening, occurring in fibers or threads. The best is known as Russian, and comes from Astrachan. Its specific gravity is 1.2. On boiling Isinglass it is converted into a very pure form of glue. Isinglass is used in quick drying cements with India-rubber, chloroform being the solvent.

**IDRIALIN (IDRIALIT).**—A rare hydrocarbon found in Idria, a province of Austria, where it occurs with hepatic cinnabar. A similar body is obtained in the distillation of amber. Its specific gravity is 1.4 to 1.6. Mentioned in certain rubber formulas to assist the insulating qualities of compounds.

**KAURI GUM.**—An amber-like substance varying from a soft cream white to an amber color. It comes from New Zealand, and is also known as Australian dammar. The lighter colored Kauri comes from living trees, but much of the darker is a fossil resin. It is cheaper than copal and largely used in varnishes. Kauri Gum, in connection with rubber gum and pitch, is used for treating yarns used in insulated wire coverings. Parkes added it to rubber goods where the surface was to be printed upon after curing. One pound of Kauri, 8 pounds of Gutta-percha, and 1 pound of milk of sulphur formed Richard's covering for insulated wire.

**LAC.**—See Shellac.

**LITHO-CARBON.**—A kind of asphalt large deposits of which are found in the State of Texas. It was at one time thought that it would supersede India-rubber, and a company was formed with the idea of manufacturing goods from it. This was in 1892, and India-rubber is still used. The chemical composition of Litho-Carbon is 88.23 carbon, 11.59 hydrogen, .06 oxygen, a trace of sulphur. Litho-Carbon is jet black in color, is flexible at ordinary



temperatures, and is quite tough. Its specific gravity is about 1.028. It is said to be soluble in naphtha, benzol, bisulphide of carbon, etc. It will stand a temperature of 600° F., without giving off its associate products. It resists alkalies and acids, with the exception of concentrated nitric and sulphuric acids. Its manufacture was patented. Used with Gutta-percha and shellac it makes an excellent insulator.

MANILA GUM.—See Gum Elemi.

MANJACK.—A kind of asphaltum of which there are extensive deposits in Trinidad, West Indies. Used chiefly in varnishes.

MASTIC.—A resin from the shores of the Mediterranean. It occurs in tears of a pale yellow, is brittle, and of a faint balsamic odor. It dissolves in acetone, turpentine oil, and alcohol, and is largely used in varnish. The residue obtained in the purifying of mineral asphalt is also called Mastic. It is used in general rubber cements for joining stoneware, earthenware, leather, etc. One of special value calls for 10 parts of Mastic to 1 part of India-rubber, dissolved in chloroform, and makes an excellent cement for fastening letters to glass. The gum also appears in many old fashioned compounds.

MENTHOL is obtained from the oil of peppermint coming from Japan and China, or from the oil of spearmint manufactured in the United States. Its melting point is about 108° to 110° F., and it is slightly soluble in water, but freely in alcohol. It is often used in medicinal plasters which have rubber for a base.

MINERAL INDIA-RUBBER ASPHALT is the name of a material composed of refuse tar produced during the refining process of tar by sulphuric acid. It is black, like ordinary asphalt, and quite elastic. It is an excellent non-conductor of electricity, and is not assailed by acids or alkalies. In a naphtha solution, it yields a waterproof varnish for metallic objects, and is used in rubber compounding in place of asphalt.

MINERAL TALLOW, also called Hatchetine, is a substance found in Siberia, Germany, and Great Britain. It is an earth wax that is soft, flexible, and runs from yellow to yellowish white. It has no smell, and melts at from 115° to 170° F. It is composed of 14 parts hydrogen and 86 carbon. Mineral Tallow is used sometimes in place of earth waxes in insulated wire work,



and has been used in paste blackings in connection with India-rubber.

**MINERAL WAX.**—A term applied to several waxy-looking hydrocarbons found as mineral deposits, such as *neft gil* (naph-tadil), ozocerite, and earth wax. It is found in Austria, and in the southern part of Russia, on the shores of the Caspian Sea. In the United States it occurs largely in Texas and Utah. Used chiefly in insulating compounds. (See Ozocerite.)

**MYRRH** exudes from the bark of a tree which grows in Arabia, in yellow drops that are quite oily at first, but which thicken and become hard and of a dark color. It appears in commerce in either grains, or tears, or in pieces of various sizes and irregular form, the color being red, reddish brown, or yellow. Its taste is bitter and aromatic, and its smell balsamic. The best gum is known as Turkey Myrrh. It is used with rubber, sulphur, and salicylic acid in complexion masks.

**NATURAL PITCH** is the name given to such kinds of pitch as are not manufactured, such as asphalt, bitumen, etc.—that is, pitch of a mineral origin, except that from coal or shale. (See Asphalt.)

**OLEO RESINS.**—A resin that contains a certain amount of the essential oil of the plant from which it exudes is so called. Chief among the Oleo Resins are certain which have a pungent taste and a peculiar, and often a pleasant odor, known as balsams.

**OZOCERITE.**—A waxy hydrocarbon occurring in Austria, southern Russia, and the United States. It is also known as earth wax. Its specific gravity is 0.9 to 0.95, and it is about as hard as talc. Chemically, it consists of hydrogen 13.75 and carbon 86.25, while its melting point extends from 140° to 170° F. It is often found adulterated with asphalt and sometimes with Burgundy pitch. Purified Ozocerite is known as *ceresine*. To make this, the crude material is treated with fuming sulphuric acid, and then filtered through charcoal. Thus prepared it is of a pale yellow color, the melting point ranging from 61° to 78° C. It has almost wholly driven out Stockholm tar as a protection for wires insulated with Gutta-percha, when placed under ground. It improves the insulation, but in spite of common belief to the contrary, does not preserve textile fabrics. The best compound for the protec-

tion of the insulation on wire consists of 3 parts of Ozocerite to 1 part of Stockholm tar. It is an insulator of high quality, and while it is in some ways intractable, its wax-like nature allows it to combine with other insulators or with textiles. It is also used as a water-repellent in fabrics, the gum being volatilized by heat, and the fumes passed through the cloth. As a surface covering for tapes or braid, it is often employed and is better than other gums, as it takes a fine polish from the polishing machine. The basis of Henley's system of curing India-rubber core is melted Ozocerite, which is used under pressure to remove all the moisture, being afterward heated in hot Ozocerite, which stops up the pores. Ozocerite, mixed with India-rubber, is also the basis of the India-rubber compound called nigrite. It mixes, however, with difficulty with India-rubber, which is an objection to many proposed uses of it. It also has a mildly deleterious effect on it.

OZOCERINE is a vaseline-like substance prepared from ozocerite. There is also prepared from crude ozocerite a valuable black wax which, when fused with India-rubber, makes an excellent electric insulating material. This wax was recognized by a lecturer before the Society of Chemical Industry as the basis of the insulation known as Okonite.

PARAFFINE.—A white waxy-looking body obtained from Petroleum and certain tars by distillation. It is tasteless, inodorous, harder than tallow, but softer than wax. Its specific gravity is .877. It is also obtained from ozocerite or earth wax. Its melting point varies with the source it is obtained from. It is insoluble in water and nearly so in boiling alcohol, but soluble in ether, oil of turpentine, oil of olives, benzol, and bisulphide of carbon. It is usually very free from water, and not liable to absorb it. It has been used as a waterproofing mixture and is a good insulator. A very widely diffused bit of newspaper advice has been that to preserve rubber goods they should be dipped in a bath of melted Paraffine and dried then in a hot room. It has not been proved to be of any advantage, however. Experts in the rubber trade claim that such a course would seriously injure the elasticity and life of the rubber. When gossamer clothing was manufactured in large quantities, the surface of the goods before solarization was covered with a thin coat of Paraffine, which gave it a peculiar

shade until the solarization was completed, when all traces of the Paraffine seemed to disappear. The insulating capacity of rubber to which Paraffine has been added is quite remarkable, but at the same time it lessens the hardness of the rubber to a marked degree. Rubber dissolved in Paraffine wax forms a curious compound which has been used in insulation. Paraffine is used in the artificial gums like Parkesine and insulite; also with cottonseed oil and resin for cheap Brattice cloth, and in cheap proofing compounds. It is not a great favorite as an insulator, as it shrinks in cooling, causing cracks. Paraffine tapes are also easily destroyed through the presence of free acid. It was formerly used largely in covering annunciator wires, but as it was found to absorb and retain water, its use was given up, and its place taken by a compound of Paraffine, ceresin, and resin.

PITCH is the black residue that remains after the distilling of wood tar. Varieties are also obtained from coal tar and from bone tar. Wood pitch, however, has a toughness which the others do not possess. Pitch was used very early in considerable quantities in hard-rubber compounds. Goodyear, for example, used considerable of it in hard compounds for coating metal, the rest of the compound consisting chiefly of rubber and sulphur. It is almost the only organic substance which largely increases the resiliency of India-rubber. It is largely used in cements, and also in many rubber compounds. Equal parts of pitch and Gutta-percha make a tire cement for fastening to the rims, known as "Davy's Universal Cement." It is used with Gutta-percha in shoemakers' wax, and also in certain proofing compounds. Wood cements made of Gutta-percha as a rule contain a certain amount of Pitch. It is also used in the manufacture of Fenton's artificial rubber.

RESINS.—The term given to a number of complex bodies, generally the hardened exudation of sap from trees. Chemically a resin is the substance obtained by the gradual oxidation of an essential oil. The specific gravity ranges between 1.02 and 1.2. Resins are divided, as a rule, into three classes—hard, soft and gum resins. The former at ordinary temperatures are solid and quite brittle. They contain little or no essential oil, and are easily pulverized. Shellac and sandarac are good examples of this kind,

and soft resins are usually called balsams, and are either semi-fluid, or soft enough to be molded by hand. They are really mixtures of hard resins, and the essential oils found in the plant from which they come. On exposure to the air they become in time hard resins. Of this class are balsam of storax, tolu balsam, etc. Gum resins are the solidified milky juices of certain plants. They consist of a mixture of resins, essential oils, and a considerable proportion of gum. These are, for example, gum euphorbium, galbanum, and to this class also belong India-rubber and Gutta-percha. Most of the fossil gums, such as copal, are resins whose physical characteristics have been changed by their having been buried for a long time in the earth. These fossil resins are counterfeited to an extent by treating ordinary resin with lime, which raises its melting point considerably.

RETINITE.—Also known as Retin Asphalt. It is a fossil resin found in brown coal. It is found in roundish masses of a yellow brown or reddish color, is quite inflammable and readily dissolves in alcohol. At present it is somewhat rare, but if it ever should become common, it would undoubtedly find a place in rubber compounding. Its specific gravity is 1.07 to 1.35.

ROSIN is made from common turpentine, which is distilled in water, yielding nearly one-fourth its weight of essential oil, the residue in the retort consisting of common rosin. Rosin is also very generally called colophony, its true chemical name distinguishing it from other resins. There are two varieties of rosin in common use, the brown and the white. The first named is brittle, solid, and of an amber color, and comes from the Norway spruce fir. The white rosin is obtained from the pine and is known as galipot. Rosin dissolves very freely in alkaline solutions, which allows of its use in soaps. Its specific gravity is 1.08. There are three grades commonly on the market, which are called virgin, yellow dip, and hard. It is used in a great variety of rubber compounds, its chief uses being in frictions, dry heat varnishes, cements, and the puncture fluids. Almost all lines of rubber manufacture use a certain amount of it at times. Only a small proportion of it can be used in rubber compounding, its office being usually that of the sticker. A large amount of it induces surface cracking, and often a decided bloom-



ing of the sulphur. It is also used in waterproof solutions in conjunction with spermaceti, India-rubber, and paraffine wax. Mixed with boiling oil, it has been applied to Gutta-percha articles to give them a Japan-like luster, and is also important in Gutta-percha glue, which is compounded of Gutta-percha, powdered glass, litharge, and Rosin. A very large use for it is in the rubber channel cements that are sold to leather shoe manufacturers.

SANDARAC.—Also known as Gum Juniper (which see).

SEEDLAC.—See Shellac.

SHELLAC, STICKLAC, SEEDLAC, GUMLAC.—All these are different names for the same thing or different stages of its preparation. It is the exudation formed on several sorts of trees growing in the East Indies, but is chiefly produced from the banyan tree, the exudation coming from a scale shaped insect known as the *Coccus lacca*, the female fixing herself to the bark and exuding the resinous substance from her body. In addition to the East Indian product there is what is known as Mexican lac, which exudes from the *Croton draco*. Sticklac is the resin as taken from the tree. Seedlac consist of fragments broken from the twigs and partly exhausted by water. Shellac is prepared by melting Stick or Seedlac, straining, and pouring upon a flat surface to harden. It is then washed, dried, melted, roughly refined, and sent to market, or it is poured into molds to harden and is known as Button or Garnet lac. The specific gravity of Lac is about 1.139. It is partially soluble in alcohol, turpentine, chloroform, and ether, and is completely soluble in caustic alkalies and borax solutions. Shellac was formerly used very generally in rubber manufacture in surface goods, and particularly in solarized goods in small proportions. It has a specific use to-day in the production of water varnishes for surface goods. It is also a constituent in the production of certain compounds in hard rubber, and particularly the semi-hard varieties, being used to the extent of 20 per cent. of the amount of gum. Although quite brittle, it seems to impart a certain elasticity to the product. The maximum use of Shellac in a hard-rubber compound, according to Hoffer, is 88 parts India-rubber, 50 parts Shellac, and 12 parts sulphur. It is also used in certain of the Jenkins patented packings to the extent of 10 to 25 per cent. of the amount of rubber, where it is said to preserve



the compound from the effects of coal oil, steam, or hot water. It is also used in many cements both with and without India-rubber, one formula for marine glue being: 20 parts shellac, 12 parts benzol, and 1 part India-rubber mixed with heat. Dissolved in 10 parts of strong aqua-ammonia, it forms a varnish for rubber goods, and is also used as a solution for re-varnishing old rubber shoes. Used with carburet of iron and bisulphide of mercury as a cement for card clothing, with India-rubber and Gutta-percha for attaching shoes to horses, in English "alcement," and in certain proofing compounds.

SIZE.—A weak solution of glue, sometimes used in shower-proof compounds and cements. The name Size is also often applied to any thin viscous substance, as for instance, gilders' varnish. In rubber practice, however, the glue Size is what is ordinarily employed. It is also used in preparing a perfectly smooth cloth upon which rubber is to be calendered, and from which it is stripped before the making up. (See Glue and Gelatine.)

SPRUCE GUM is used with chicle in the production of chewing gums. Melted spruce gum or rosin is known as Burgundy pitch (which see).

STEARINE.—A white waxy-looking body obtained from fats—chiefly tallow and palm oil. When made from tallow it is called pressed tallow or tallow Stearine, which is the solid part obtained from the heating of suet fat and the removal of the liquid part which is oleomargarine. Tallow Stearine is very largely used in candle making, where is found saponified Stearine, distilled Stearine, and distilled grease Stearine. This latter contains considerable cholestrol and differs from commercial stearic acid or Stearine chiefly in its physical structure. Stearine is used in proofing compounds, in rubber blackings and in compounds containing resins. It has been suggested that a small proportion of Stearine in certain rubber compounds that contain low grades of rubber which in themselves have large proportions of resin, has a decided value in preventing oxidization.

STEARINE PITCH.—The brown tarry residue left in the still during the process of refining tallow and fat. Used in the manufacture of certain packings that contain no rubber. Stearine

Pitch is also used as a lubricant for bearings that have a tendency to heat.

STICK LAC.—See Shellac.

STOCKHOLM TAR is used in black cements of the marine glue class, and is also used in rubber compounding, its office being to assist in the mixing of dry compounds, and as a binding material for sulphur in the dry heat cure. Also used in manganese cements and in cements to fasten tiles to floors. (See Tar.)

SPERMACEIN.—A peculiar fatty concrete substance obtained from the head of the sperm whale. Its specific gravity is 0.943, and it is fusible at 112° F. Insoluble in water, soluble in hot alcohol, ether, and oil of turpentine, but redeposited as the liquids cool. Was formerly used in certain waterproofing compositions.

SLUDGE OIL RESIN.—A heavy gummy residue from the waste of superphosphate factories. Has been used with rubber in making Japan varnishes.

TAR.—This substance is derived from the animal, vegetable, and mineral kingdoms. From the first, by the destructive distillation of bones, is produced what is known as "Dippel's oil"; from the second, by the distillation of pine woods, the product is known as pine tar or Stockholm tar; and from the third, by the distillation of coal, is produced coal tar. Of the three, coal tar is the most used in rubber work, its office being to help carry adulterants in dry mixing and to keep the sulphur from blooming after vulcanization. It is used chiefly in dry heat work. Good-year discovered early that very large quantities of boiled tar could be used in connection with India-rubber and sulphur without injuring the quality of the gum, and it has been very generally used since his time.

TRINIDAD ASPHALT is obtained from the pitch lakes of the island of Trinidad. Its specific gravity is 1.2, and it is somewhat soluble in alcohol, while Persian naphtha, oil of turpentine, benzol, and benzoline readily dissolve it. (See Asphalt.)

TOLU BALSAM is derived from a tree found on the mountains of Tolu, and the banks of the Magdalena river, in Colombia. It is very similar to balsam of Peru. It sometimes appears in commerce in dry friable fragments, the newly imported gum being soft and tenacious. It has a very fragrant odor, and a medicinal

and tonic effect. Tolu Balsam is used with paraffine wax and chicle in chewing gum compounds.

**TURPENTINE.**—This is a semi-solid resin, which comes from various species of pine as a rule. The chief commercial varieties are common Turpentine, which comes from the *Pinus palustris*; Venice Turpentine, from the larch; Bordeaux Turpentine, from the *Pinus maritima*, and China Turpentine, from the *Pistacia lentiscus*. Of these the Venice Turpentine is said to be the best. It is of a pale yellow color, transparent, has a bitter taste, but a balsamic odor. Used instead of rosin in many compounds.

**VEGETABLE PITCH.**—The residue left after distilling the tar made from wood of various trees. Called vegetable to distinguish it from the mineral pitch which is derived from coal. (See Pitch.)

**XANTHORRHOEA GUM** is somewhat similar to shellac, is abundantly produced in the Australian colonies, and sometimes used in the compounding of ebonite. Xanthorrhoea Gum is also sometimes known as gum acaroides, and is produced from the Australian grass tree.

**XYLOIDIN.**—An artificial gum much resembling pyroxylin obtained by the action of nitric acid on starch.

**XYLONITE.**—See Zylonite.

## CHAPTER IX.

### PIGMENTS AND PROCESSES USED IN COLORING INDIA-RUBBER.

Most of the India-rubber goods now manufactured are black, this color, if it may be so called, being produced in a measure by the color of the rubber, together with the leads and other ingredients, most of which darken during vulcanization. The next prominent color, from a rubber standpoint, is white, produced by either an oxide or sulphide of zinc. Next to this range the yellows and reds, produced by the use of sulphide of antimony and vermilion.

So many colors are unstable when brought in contact with sulphur during the heat of vulcanization, and it is so difficult to get good effects, that it is hardly to be expected that beautiful colors in India-rubber will ever become common. There are various methods used for changing the natural color of India-rubber. The usual way is by incorporating, by mechanical mixture, earthy pigments or metallic oxides or sulphides, or vegetable coloring matters, which, by their covering property and strength, give to the India-rubber their own particular shade. There are other methods, however. For example, there have been produced anilines soluble in benzine, that are used for surface work, such coloring being really an elastic enamel. Toys and minor articles that are ornamented in very bright colors, however, are generally painted over after vulcanization, but paint is not durable, nor does it long remain beautiful.

While it is claimed ordinarily that it is impossible to dye India-rubber, it should be remembered that the attractive colors that appear on childrens' toy balloons and similar pure gum goods are applied as dyes, the colors being anilines, with methylic alcohol as a base. These colors are boiled in rainwater, and when the solution is cold the balloons are put into the coloring liquid and turned so as to have their entire surface wetted. After that, they are dropped into cold water, which washes off the superfluous color. When this is done properly, the rubber does not give off any stain at all after the first washing. The colors used in this

way are red, green, blue, orange, and pink, but other shades are equally available.

In Germany a full line of aniline colors soluble in benzine is now manufactured, and for surface coloring of rubber goods they have been found very valuable. Although they are not absolutely fast, they are sufficiently so for all practical purposes. In many cases, these aniline colors, being soluble in benzine, can be mixed right with the India-rubber—that is, when it is used in the form of solution. If the product be cured in open steam heat with sulphur, some very curious effects are likely to be obtained. This was proved at one time when a line of rubber colors was put on the market in the United States, with white oxide of antimony as a base, and anilines to give various shades. It does not often happen, however, that a problem of this kind confronts the users of aniline colors in rubber, the more general and sensible way being that of surface coloring. This is done in some cases by simply brushing the aniline color dissolved in benzine over the surface of the article. It is desirable, however, first to dip the goods in the dissolved mordant, and then to use the brush, if necessary. Where a high polish or a polished effect is desired, some sort of elastic lacquer must be put on over the coloring matter. A very thin India-rubber solution is often used for this.

In speaking of anilines, it must be remembered that those that have to be worked up with acids should be avoided for rubber work, but there are so many others that there is no need of the rubber man making this mistake. Where colors are to be printed upon rubber surfaces, a little dextrine is added to the aniline dissolved in benzine, and to make the color dry faster, a little sulphate of manganese mixed with half of 1 per cent. of alum and added to the mass is advisable.

Black, blue, red, yellow, and green anilines are also used in coloring rubber cements that go to the leather shoe trade. These and other anilines are also used very generally in artificial leather compounds. Aniline, black, is used in water varnishes for luster coats and blankets.

It is also a good idea to sponge the rubber surface with a water solution of alum before the color is applied. The use of alum as a mordant may be supplanted by bisulphate of soda, if it



is desired. The best colors available in the aniline series are reds, particularly magenta reds, and the marine and alkali blues.

A great many methods of surface coloring have been devised, some of them being ludicrous attempts at dyeing rubber. The surface of rubber is, of course, not easily affected by colors, unless it has first been attacked and roughened by some powerful solvent. Malcolm's process for this surface coloring is perhaps as harmless as any. This method is to expose the rubber to the sunlight while it is immersed in alcohol. When the surface is somewhat disintegrated, the rubber is taken out, washed, and dipped in a dye solution.

The colors that follow are described very briefly, and most of them are such that any rubber manufacturer can easily secure them for use or for experiment.

#### WHITE.

ONLY a few colors are available for use in making white rubber goods. Of these, the zincs take the lead, being by far the most constant and valuable. They lend their color to the mass simply by their presence as dry paints with strong coloring qualities.

**BARIUM WHITE.**—This is also called constant white, and comes from the sulphate of barium or heavy spar. In treatment, it is ground very fine, treated with hot hydrochloric acid, washed, dried, sifted, and then forms a fairly white, dense, impalpable powder. The pure article, obtained by precipitation, is a brilliant white, and is often used in rubber compounding. It is one of the few metallic colors that the German anti-poison act allows manufacturers to use in any way they please. (See Barytes.)

**BECKTON WHITE.**—See Lithophone.

**BORATE OF ZINC.**—A zinc salt, precipitated by 20 to 30 per cent. of a soluble borate, the result being a white powder, which is claimed to have a distinctively preservative influence when used in rubber, while the tensile strength of the gum is much enhanced.

**BOUGIVAL WHITE** was a fairly common white pigment, although it has been replaced by barytes, terra alba, and whiting. Bougival White is a white, marly, china clay found at Bougival, near Marly, in France. The district surrounding Bougival and

also Normandy and Auvergne contain many beds of white clays, notable for their smooth qualities of good color. Roughly Bougival White contains 33 per cent. chalk (carbonate of lime) and 67 per cent. kaolin (hydrated silicate of aluminium).

**CALAMINE WHITE.**—This is prepared from the native carbonate of zinc, by calcining and grinding. It is not a strong white, and is not nearly as good as the oxide or carbonate of zinc as a coloring matter. For a cheap white, and a filler, however, it is useful. Although the German anti-poison act of 1887 prohibits the use of zinc as a coloring matter, it does not apply to its ordinary use in rubber compounding. They rule that zinc compounds not soluble in water may be used in rubber when and where the coloring matter is mixed in the mass before vulcanizing, or as a color layer on the surface if it is covered with a lacquer varnish.

**CARBONATE OF ZINC.**—This is a form of zinc rarely known to-day in rubber mills. The first white rubber, however, was made of it under a patent granted to that eminent rubber manufacturer, the late Henry G. Tyer. It is a white powder, and is made by mixing a solution of equal quantities of sulphate of zinc and carbonate of sodium, and subsequently the boiling of the white precipitate formed for a short time.

**CHARLTON WHITE.**—See Lithophone.

**FARD'S SPANISH WHITE.**—Also known as Pearl White. A tri-nitrate of bismuth, and a white that, it is said, has a future in rubber compounding. It is not easily affected by atmospheric influences, or by the action of sulphurous compounds.

**FULTON WHITE.**—See Lithophone.

**GRIFFITH'S WHITE** is a sulphide of zinc of English manufacture, prepared by precipitation, and containing a certain proportion of magnesia.

**KREMnitz WHITE** was the name of a somewhat indefinite white. In some cases it was applied to white lead, but in others was given to bismuth white (oxide of bismuth) and often to white oxide of tin.

**LITHOPHONE** (also **LITHOPONE**).—A white pigment made by precipitating sulphate of zinc with barium sulphide. The barium sulphide is made from the native barites by heating with charcoal,

which reduces the sulphate to sulphide and polysulphide, which are soluble in water. The zinc sulphate is made by roasting zinc blende or the ore "black jack" under oxidizing conditions, which forms soluble sulphate of zinc. Both substances are dissolved in water, which purifies them from many impurities, and the two solutions mixed, when zinc sulphide and barium sulphate both precipitate out as fine powder mixed with free sulphur from the polysulphide. The powder is dried and roasted, which drives off free sulphur and produces some free zinc oxide. Gives a fine white; but may turn gray on long exposure to light. This defect not so bad for rubber as for painting. It is a constant white, and is largely used instead of oxide of zinc for white goods, particularly in the manufacture of druggists' and surgical sundries. The commercial article contains 70 per cent. of Barium sulphate and 30 per cent. sulphide of zinc. Its specific gravity is 3.6 to 4.1.

**MOUDAN WHITE or MORAT WHITE.**—This white came from the Pays de Vaud in Switzerland, Moudan and Morat being two towns in that district. It was a fine white clay with a silky luster and a fine grain. They resembled Spanish white and were often used in place of it.

**OLEUM WHITE.**—A high grade of sulphide of zinc, in which is a certain proportion of blanc fixe. It is a trifle heavier than a pure sulphide of zinc, but in practice has been found to be equal to if not better than either the sulphide or oxide of zinc in the manufacture of certain white rubbers.

**ORR'S WHITE.**—See Lithophone.

**OXIDE OF ZINC** is used more than any other coloring matter in the production of white rubber. It is especially valuable because during the process of vulcanization it increases the whiteness of the goods. This is because the part of the zinc oxide that is turned into the zinc sulphide is a stronger white than the first. Oxide of Zinc made of pure spelter is the best. Where lead and zinc ores are found together it sometimes happens that the oxide contains a certain amount of lead, and then its value as a coloring matter is injured. It is prepared by two processes, an air blast, and a steam current; in other words, by a dry and a wet process. That prepared by the wet process, even when strongly heated,

contains more water than does that produced by the dry process. The specific gravity of zinc oxide is 5.61. A certain percentage of this oxide is often added to dark colored goods to increase the resiliency of the rubber. It also increases the hardness of a compound where soft gums are used. Manufacturers of insulated wire find that it increases the insulating qualities of rubber when added in moderate quantity.

A very simple test for zinc oxide is as follows: Put a small quantity in a test tube or vial and add diluted muriatic acid (such as can be obtained in any drug store); agitate to dissolve all lumps, and if it be commercially pure oxide of zinc, no residue will remain. The only adulterant likely to be found which would not leave a sediment would effervesce violently. Should the addition of acid to the pigment produce sulphureted hydrogen, the odor of which is unmistakable, no doubt would exist that the sample is not oxide of zinc and probably a much cheaper pigment. There are many pigments on the market called zinc and containing some zinc in various forms, which have their uses, but should not be confused with straight oxide of zinc.

ROSS'S WHITE.—See Lithophone.

ROUEN WHITE was a marly clay found near Rouen in France, prepared for use by levigation. In most respects it resembles Bougival white.

SPANISH WHITE is a name often now given to a good quality of whiting, but originally given to a good kaolin clay prepared for sale by first levigation, then treatment with vinegar, which separated out any calcium carbonate it contained, then washing well and drying.

SULPHIDE OF ZINC.—This is a white that is fully equal to the popular oxide, and does not alter its tint under the influence of sulphur and heat. It is said to exert a distinctly preservative action upon India-rubber. Sulphide of zinc, pure and in combination with other materials, and under various names, has been sold very largely to rubber manufacturers. It is deemed especially valuable in white goods cured with dry heat. It is used in high grade white stocks, and even in pink dental rubber. It also assists in the vulcanization of rubber.

TROYE'S WHITE is a carbonate of lime, and, therefore, was

in all respects like the modern whiting. It was a very common pigment at one time and much used for a variety of purposes.

**ZINC WHITE.**—See Oxide of Zinc.

#### **BLACK.**

THERE are more methods of getting black rubbers than almost any other color, as the tendency of the gum itself is to darken under heat and the action of sulphur, and the sulphides of most materials that are used in the compounding have the same effect. Most rubber goods are made up without regard to color, and are usually a dirty brownish-black, tempered by the yellow of the sulphur bloom. Where a genuine black is wanted, however, some of the vegetable blacks or perhaps certain of the leads are employed. Lampblack is one of the most common ingredients used.

**LAMPBLACK.**—Pure Lampblack is pure carbon, as indeed is the diamond. Lampblack, however, is carbon in its amorphous or spongy form, while the diamond is crystalline. It is obtained on a large scale by collecting the smoke produced during the combustion of oils, fats, resins, coal, gas, tar, wood tar, petroleum residues, dead oil, and even bituminous coal. This accounts for the various grades that are to be found on the market. Large quantities of Lampblack have also been manufactured from natural gas. There are many types of Lampblack, the best in the world being employed in the preparation of Indian ink. This is made from burning camphor, a lower grade being made from the mixture of camphor and other oils. The smoke is collected on leaves, washed, dried, and sifted with the utmost care. The lines of rubber goods in which it is generally found are rubber boots and shoes, surface clothing, and carriage cloth, druggists' sundries (where the leads are deemed dangerous), and in certain compositions where emery is the chief ingredient used for grinding or polishing. A curious fact about Lampblack is that a little bit of it in unvulcanized erasive rubber seems to assist the erasive quality, and does not cause smutting. A little of it is also sometimes added to churning mixtures that do not readily mix. The following analysis of the composition of lampblack is given by Braconnot:



Carbon .....	79.1
Water .....	8.0
Resinous matter .....	5.3
Bituminous matter or pitch .....	1.7
Sulphate of ammonium .....	3.3
Sulphate of calcium .....	.8
Sulphate of potassium .....	.4
Chloride of potassium .....	traces.
Phosphates of calcium and iron .....	.3
Siliceous or earthy matter .....	1.1
Total .....	100.0

The analysis of lampblack from a large black manufactory in the United States:

Carbon .....	79.1
Empyreumatic resin	{ soluble in alcohol ..... 5.3 insoluble in alcohol ..... 1.7
Humin .....	
Sulphate of ammonium .....	3.3
Sulphate of lime .....	0.8
Sulphate of potash .....	0.4
Phosphate of lime .....	0.3
Water .....	8.0
Chloride of potassium .....	trace only.
Sand (accidental) .....	0.6
Total .....	100.0

BONEBLACK, also called animal charcoal and sometimes ivory black, is a black powder obtained by grinding the product of bones that are burned at a red heat in close vessels. It resembles vegetable charcoal, but is more dense and less combustible. A good quality should have an even color, of a rather dull shade. On analysis, boneblack shows the following:

Phosphate of lime .....	78.0
Phosphate of magnesia .....	1.5
Carbonate of lime .....	8.5
Carbon .....	10.0
Impurities, silica, iron, etc. ....	2.0
Total .....	100.0

SULPHIDE OF LEAD.—This is a valuable coloring matter for rubber, as it gives a good black, besides which it makes goods exceedingly resilient. There are great differences in the production of lead sulphides, but, as before remarked, a good one is of special value to rubber manufacturers. (See Leads.)

MINERAL BLACK is a pigment that is said to be made from bituminous lignite. It is very porous, and is not recommended

for rubber work. A very little ultramarine blue added to a black in rubber sometimes overcomes the grayish shade.

**SULPHIDE OF URANIUM.**—A fine black pigment more intense than plumbic blacks. It is a permanent color, and is said to be a preservative of rubber.

**BLACK HYPO.**—This is also known as hyposulphite of lead. It is really a mixture of thiosulphate of sodium mixed with acetate of lead, and appears as a fine white crystalline precipitate, which should be called thiosulphate of lead. There are two forms, the white hypo and the Black Hypo, the difference being that the white when heated is transformed into a soft black powder containing very little free sulphur. The black of the compound being sulphide of lead often contains over 90 per cent. of pure sulphide. It is an excellent vulcanizing agent, and also a filler. When properly prepared it makes goods absolutely free from bloom.

**CARBON BLACKS** of late have been used very largely in rubber compounding and have done excellent work. They are not as black, as a rule, as the better grades of lampblack made from oils or resin. They are in many cases wholly inert, however, and therefore perfectly safe to use. One of the best types of this sort of coloring matter comes from a graphite mine in the United States. It is wholly amorphous, and has none of the flaky make-up that ordinary graphite has, and is 97 per cent. pure carbon. Carbon Blacks, it is also said, give a brighter finish to varnished goods than ordinary lampblacks.

**OAK BLACK.**—A product of the distillation of oak wood after draining off (1) wood alcohol and (2) a product resembling tar. It is used in certain black insulating compounds in connection with shellac, coal tar, paraffine, and asbestos.

#### BLUE.

**BLUES** are not largely used in general rubber work. They are found chiefly in toys, in sheetings, and in certain packings. The most important blue is—

**ULTRAMARINE.**—This is made from lapis lazuli. The exact composition of this coloring matter is not known, but it is said to be based on a silicate of alumina with sulphide of sodium. An

artificial ultramarine is often produced which is equal and often superior to the natural pigment. This is made of kaolin, carbonate of sodium, willow charcoal, and sulphur. The following analysis of the natural Ultramarine is given:

Silica .....	37.6
Alumina .....	27.4
Sulphur .....	14.2
Soda .....	20.0

Analyses of the best artificial Ultramarines show these figures:

Silica .....	40.25	39.39	40.19
Alumina .....	26.62	24.40	25.85
Sulphur .....	13.42	12.69	13.27
Soda .....	19.89	21.52	20.69

Ultramarine appears in commerce as a fine blue powder of various standards of fineness. Acids readily destroy it, but alkalis have no effect on it. It stands heat well, not changing below a low red. It is used in cements for backs of memorandum blocks, and in blue soft rubber goods, particularly in vapor cured goods, such as sheeting. When mixed with chrome yellow it makes a green; with colcothar, it makes a violet. Mixed with rose pink, oxide of zinc, and Indian red, it produced the well-known wine-colored coat that was so popular a few years ago. It is claimed that Ultramarine blue keeps rubber from overcuring, and that it is, therefore, a most useful ingredient to add to compounds that are exposed to heat.

YALE BLUE.—In certain soft rubber goods, where a strong blue is needed, ultramarine was found unsatisfactory. A firm of rubber chemists therefore produced Yale Blue, which is a strong coloring matter, and wholly inert as far as the rubber is concerned.

SMALTS.—This is what may be called a deep tinted cobalt glass. The analysis of Smalts of good quality is as follows:

	Deep Colored Norwegian	Pale Colored German
Silica .....	70.9	72.1
Potassa (with traces of soda and lime) .....	20.4	20.0
Oxide of cobalt .....	6.5	2.0
Alumina .....	.4	1.8
Peroxide of iron .....	.3	1.4
Other earths and oxides, and loss .....	1.5	2.7
Total .....	100.0	100.0

This is one of the few colors that are practically indestruct-

ible. In using Smalts for the pigment, large quantities are necessary, as the color is not exceedingly strong.

**COBALT BLUE** is manufactured from oxide of cobalt, phosphate of cobalt, and alumina. It is rarely used in coloring rubber where the ingredients are to be mixed with the mass, ultramarine being much superior. Also called Smalts.

Thenard's blue is similar to cobalt blue, but is a more beautiful pigment. It is used chiefly as a surface color. White pigments in small quantities added to this blue make beautiful turquoise colors.

**PRUSSIAN BLUE.**—A dark brilliant blue compound, having iron for a base. There is a soluble and an insoluble variety of this compound which is of a somewhat complex chemical constitution. Heated strongly in the air, the insoluble form of Prussian Blue burns like tinder. When boiled with caustic potash, it is decomposed. If the dry powder be strongly rubbed in a mortar, it assumes a copper red luster. In commerce it occurs in irregular shaped masses, having a characteristic conchoidal fracture and copper red luster.

**CHROME BLUE** is manufactured from silica, fluor spar, and chromate of potash. The resultant material is a deep blue vitreous mass which is reduced to an impalpable powder. It is less sensitive to acids than ultramarine, and is better adapted for rubber goods.

**SAXON BLUE** is the original name of the pigment known to-day as smalts; it was also very frequently called enamel blue. Under this name was also sold a blue pigment made by mixing Prussian blue with alumina or a white clay.

**MOLYBDENUM BLUE.**—A pigment recommended by Lascelles-Scott is a bisulphide of molybdenum. It is an exceedingly beautiful blue, but costly. Large new deposits of this mineral have been found in the United States and Australia, and Norway, and it is likely to be so cheapened that it will be a valuable rubber pigment.

**INDIGO BLUE** is prepared from plants of the *Indigofera* genus. Pure Indigo is insoluble in water, nor is it soluble in weak acids or alkalies. A small percentage is dissolved in alcohol and its solution is more considerable in turpentine. Indigo Blue for rub-



ber is said to be valuable on account of its preserving qualities, which are double those of other blues.

## RED AND BROWN.

THE strong red coloring matters used in rubber work are mostly of a mercurial base. These are vermilion, red chromate of mercury, sulphide of mercury, and iodide of mercury. The Chinese vermilion, which is the best, is prepared by a special process of their own, and contains 89 per cent. of pure mercury, the rest being sulphur. This coloring matter is used very largely in dental vulcanite, small amounts of it also giving excellent shades in soft rubber goods. Cinnabar and Paris red are also mercurial sulphides, and very strong colors. The sulphides of mercury are really the only ones that are safe and valuable for producing these colors. Red chalk and natural clay containing a certain amount of iron are used chiefly as fillers in rubber goods, although a certain quantity of them produce a dark red color.

VERMILION.—The red form of mercuric sulphide is a scarlet red powder of specific gravity 8.124. It is sometimes adulterated with red lead or red oxide of iron, but such adulterations can be detected by heating a small sample of the suspected article on a porcelain or platinum dish. If any adulterant is present it will remain behind as a residue, since pure Vermilion is completely volatile. This substance is sometimes called cinnabar. A substitute for Vermilion in hard rubber was brought out by John Haldaday in 1870. This was a mixture of garancine and cochineal, in water solutions, boiled and mixed in the proportion of 5 parts of garancine liquor to 1 part of cochineal liquor. To each gallon of this compound liquor 2 pounds of pure oxide of antimony were added; then heating until the water was evaporated and the new coloring matter perfectly dry. Another substitute for vermilion was white oxide of antimony. According to A. D. Schlesinger, the veteran of hard rubber experts, white oxide of antimony, when mixed with India-rubber and sulphur, will, during vulcanization, impart to hard rubber a light red color very similar to that obtained by the use of Vermilion. The proportion of sulphur is the same as is used ordinarily in making vulcanite, while to each pound of rubber are added 12 ounces of antimony sulphide.



**RED OXIDE OF IRON.**—This is familiar as iron rust. The best is artificially prepared from green vitriol iron sulphate, and forms a scarlet powder of a specific gravity of 4.46. This contains about 5 per cent. water of crystallization, which cannot be driven off at temperatures up to 212° F., and with difficulty at higher ones. (See Colcothar.)

**PEROXIDE OF IRON.**—An old name for the sesquioxide of iron, now called ferric oxide. (See Oxide of Iron.)

**PRINCE'S METALLIC PAINT.**—An oxide of iron.

**INDIAN RED.**—Another name for oxide of iron.

**RED HEMATITE.**—An ore of iron, somewhat soft and friable. Specific gravity 5.19 to 5.28. Composition 70 per cent. iron, 30 per cent. oxygen. Insoluble in water, alcohol, or rubber solvents. As a colorant in rubber work it is unchangeable chemically. Used in packings and for red maroons.

**VENETIAN RED.**—See Colcothar.

**RED OCHER.**—An impure oxide of iron. A dull red earthy substance containing clayey matter, and having a specific gravity of about 5.2. Used chiefly as a filler, as the color is not strong. As far back as the time of Dr. Mattson, Red Ocher, Venetian red, and Indian red, were advised by him for use in rubber compounding. Indeed, he obtained a patent for packing in which Venetian red was the principal adulterant.

**ORANGE VERMILION** gives a very handsome color in connection with rubber, but is rarely used, as it is not permanent if other metals, such as copper, brass, iron, and zinc, come in contact with it.

**CRIMSON SULPHIDE OF ANTIMONY.**—This is altogether the best antimony color now in use. It not only gives a fine shade of orange or red, but it also is an excellent vulcanizing agent.

**COLCOTHAR.**—A form of oxide of iron of the specific gravity of 4.8 to 5.3. It is the residue left in the manufacture of fuming sulphuric acid from green vitriol. The least calcined portions, which are scarlet in color, are termed jewelers' rouge, and the more calcined parts, of a bluish shade, are called crocus. Its composition is that of ferric oxide. In its reaction it is indifferent, being very stable under ordinary conditions. Colcothar is a dull red and is often used in red packings, soleings, etc. Many rubber

chemists prepare their own Colcothar, as they are able to get brighter shades than is possible from the goods ordinarily sold in the open market.

UMBER.—A brown earthy mineral, containing chiefly the oxides of iron and manganese. The following analysis, by Professor A. H. Church, is taken from a choice specimen of Cyprus Umber: Oxide of iron, 48; oxide of manganese, 14; silica, 13.7; water yielded at a heat of 212° F., 4.8; mixture of lime, magnesia, alumina with organic matter, 14.5. In using Umber for rubber compounding, care should be taken to dry the material thoroughly at 212° F., before it is used. Burnt Umber is the product obtained by roasting the above material. It is slightly redder in color and will naturally contain less water. For brown colors, in addition to Umber, various natural earthy matters are used, as are also oxysulphide of antimony and sepia, the latter being an animal coloring matter made from the bright fluid formed in the ink bag of cuttle fishes. Sienna and chestnut brown are practically the same as Umber, while Vandyke brown is made of oxide of iron, ground very fine, and is not injurious to rubber. While these ingredients are practically inert, they do not make the best of rubber compounds, as the resulting compound is apt to have a hard stony feeling.

PRUSSIAN RED is an oxide of iron prepared from copperas, and, therefore, it is the same as the modern rouge or oxide of iron.

#### YELLOW.

YELLOWS are not often demanded in rubber work, except in a few fancy articles and in hose markings. The most common is that produced by the golden sulphuret of antimony, but color is not what is sought in the use of that ingredient, but rather the excellent rubber produced by it when used instead of sulphur. Other mineral yellows used are strontium, chromium, cadmium, barium, and arsenic. Chrome yellow is made from a lead base which darkens when subjected to vulcanization.

CADMIUM YELLOW.—This is the best pigment for producing yellow in a rubber compound. It does not injure the elasticity or strength of the India-rubber in any way, and, while it has no

special effect on vulcanization, perhaps hurries it a little. It is not injurious to the health of persons using it, and is generally used for surface ornamentation of toys, etc. It is sometimes mixed with yellow sulphide of tin to cheapen it. While Cadmium was ruled against in the German anti-poison act, the sulphides of this metal were made an exception, and said to be safe. In dental plates, however, where the coloring matter was used in large quantity, it was advised against. The costliness of Cadmium Yellow at present bars its general use in rubber.

**AUREOLIN YELLOW.**—A very handsome color, and one that is stable and brilliant. It is made up of acetate of cobalt and nitrate of potassium. The color stands the light well, and sulphur compounds have little influence upon it. This is chiefly used for surface work.

**GAMBOGE YELLOW.**—Obtained from the *Garicinia morella*. It contains from 20 to 25 per cent. of gum, 65 per cent. of resin. 3 per cent. of volatile oil. It is soluble particularly in spirits, in a number of oily liquids, and partially in water. Finely pulverized Gamboge may be mixed with rubber, and is said to be a preservative of it.

**BARBERRY YELLOW.**—Made from the root or bark of the *Barberis vulgaris*. It is largely used in coloring leather surfaces, and, in connection with gamboge, is said to be useful in rubber work.

**YELLOW OCHER.**—There are several ochers, all of them being practically oxides of iron mixed with clay. They are earthy substances of no particular reaction, very stable, having a specific gravity of about 5. Their low cost renders them available for almost any work, but the colors produced are not especially beautiful.

**ARSENIC YELLOW.**—Also known as King's Yellow, and is a term applied to sulphide of arsenic. A cheap grade of this, which is really only an imitation, is manufactured by mixing together litharge and white arsenic, and grinding the product. Either of these, of course, is poisonous, and they are very rarely used or needed in connection with rubber. The specific gravity of Arsenic Yellow is 3.48. Although a sulphide, there is not enough sulphur in its composition to vulcanize India-rubber. On account

of its poisonous properties, this yellow has been largely superseded commercially by the comparatively harmless chrome yellows. Another name for this color is orpiment. It was often used in rubber compounds of twenty years ago. A small quantity in white zinc stock takes off the glaring white effect, and produces a handsome cream white. Must be in an impalpable powder to bring out the color.

**CHROME YELLOW.**—Ordinarily the chromate of lead, which is largely used as a pigment. It is somewhat poisonous and is apt to oxidize organic substances, particularly if sulphur be present. Has been used in the surface ornamentation of rubber toys, but such use is generally condemned. The only Chrome Yellows that are really valuable for rubber work are the chromate of zinc, or possibly the chromate of strontium.

**ORPIMENT.**—See Arsenic Yellow.

**DUTCH PINK** is the name given to some common yellow lake pigments made from Persian berries, quercitron bark, fustic, etc., on a base of China clay or whiting. It is mentioned here just to notice that at one time a blue Dutch pink was known, prepared from the woad plant.

#### GREEN.

It is fortunate that greens are not largely sought in the rubber industry, for they are rare. Arsenic greens in many cases are not to be thought of; therefore, about the only ones that are available, unless very high cost goods can be utilized, are the following:

**CHROME GREEN.**—A coloring matter that is not affected by strong acids, or alkalies, and which is inert when mixed with India-rubber. It is the best mineral green that can be used in connection with rubber. It is really a sesquioxide of chromium; and may be mixed with rubber, with any kind of solvent, and with other oxides and pigments, without hurt to the compounds.

**TERRA-VERTE** is of mineral origin, and is imported in large quantities from Italy. It is a pale neutral green of moderate cost, and is not injurious to rubber. On analysis it shows, as in the following table, the analysts quoted being Klaproth for No. 1 and Berthier for No. 2:

	No. 1	No. 2
Silica .....	51.50	46.00
Alumina .....	12.00	11.70
Protoxide of iron .....	17.00	17.40
Lime .....	2.50	3.00
Magnesia .....	3.50	8.00
Soda .....	4.50	..
Water .....	9.00	13.90
Total .....	100.0	100.0

GREEN ULTRAMARINE is made by a process very similar to that made in producing blue of that name, and its action upon rubber is almost identical with that of ultramarine blues.

HUNGARIAN GREEN is a similar pigment found at Kernhausen in Hungary. These greens in some respects resemble the article now known as terra-verte.

SAXON GREEN is a green earth of a clayey nature, found in parts of Saxony.



## CHAPTER X.

### ACIDS, ALKALIES, AND THEIR DERIVATIVES, USED IN THE RUBBER MANUFACTURE.

As a rule neither acids nor alkalies, in the strict sense of the term, are largely used in ordinary rubber compounding. In a great many of the processes, however, that go far to make up finished goods, acids are used, as, for example, in those employed in the reclaiming of rubber chemically. Alkalies also are most necessary, a notable example being the use of caustic potash and caustic soda solutions in removing sulphur from manufactured goods. A great variety of uses other than these may be indicated.

**ACETIC ACID.**—This is usually obtained by the dry distillation of wood fiber, peat, or sawdust. The strongest form is known as glacial and occurs in large watery crystals, readily liquefied. The common commercial acid usually has a brown or yellowish color, due to impurity, since the pure acid is colorless. Its specific gravity is 1.05, and it has a characteristic odor familiar enough in vinegar. As an acid it is not very corrosive, and its compounds are easily decomposed by mineral acids. It is quite volatile. The primary use of this acid in connection with India-rubber is in the coagulation of rubber milk. It is a prominent component part of the smoke used in coagulating fine Para rubber. It has also been used under the Vaughn process for coagulating Balata, and in the manufacture of certain substitutes like linnoxin, Parkesine, etc.; in connection with nitro-cellulose and castor oil in the production of certain waterproofing compositions; by Brooman in separating whiting, white lead oxides, etc., from vulcanized rubber; and in shoemakers' blackings in connection with caoutchouc oil, vinegar, molasses, and lampblack.

**ALE.**—A beer made from malt, distinguished chiefly by its strength and the quantity of sugar remaining undecomposed, which enables the liquor to keep, without requiring a large amount of hops. A mixture of ale and linseed oil, in the proportions of 8 parts ale to 2 parts linseed oil, is used in dissolving isinglass,

in which are afterward incorporated shellac and India-rubber in the formation of what is known as ale cement.

**ALUM.**—A general term for several chemical compounds of aluminum, potassium, chromium, and ammonium. Common alum is the double sulphate of potassium and aluminum, having a specific gravity of 1.7 and containing 45 per cent. of water of crystallization, one-quarter of which is expelled on heating to  $140^{\circ}$  F. It is soluble in water  $9\frac{1}{2}$  parts per 100 when cold, 357 parts per 100 when hot. Chrome Alum is a double sulphate of chromium and potassium, its specific gravity being 2.7, and containing 43 per cent. water of crystallization, which is almost entirely lost at  $392^{\circ}$  F. It occurs as dull purple crystals, slowly soluble in water to 20 per cent. in the cold and 50 per cent. in the hot water. Its action on gelatine is remarkable for its hardening qualities. Ammonia Alum, the double sulphate of aluminum and ammonia, is largely used in place of common alum. It contains 48 per cent. of water of crystallization and has a specific gravity of 1.63. Strongly heated, it yields sulphate of ammonia, water and a very small quantity of sulphuric acid, while alumina is left behind. It is soluble in water 13 per cent. cold, 422 per cent. hot. Roman Alum has the same general characteristics as common alum, but contains a little more alumina.

Alum is used in many of the shower-proof mixtures for cloths of the cravenette order, that are to-day bought and made up by manufacturers of mackintoshes. It is also sometimes used in the manufacture of sponge rubber. By Garnier's process it is also used in spirituous solution to cure rubber without heat by mixing with it. Used also in Wray's substitute for Gutta-percha. Alum was used in Payne's Gutta-percha compounds for proofing, varnishing, and paints. Ghislin, who prepared some curious compounds from seaweed and India-rubber, mixed alum, gelatine, and metallic oxides in his compounds. It is also sometimes used in compounding rubber to make sponge effects, and mixed with sulphate of iron and soap, in a water mixture with boiled linseed oil, to make flexible waterproofing compounds.

**AMMONIA**, at ordinary temperature, is a colorless gas of well known odor and sharp biting taste. It is usually met with in the arts in watery solution, the specific gravity of which varies with

the amount of ammonia gas dissolved. The strongest, sometimes called caustic ammonia, contains 32.5 per cent. of the gas, and has a specific gravity of .875. Ordinary commercial ammonia has a percentage of 9.5 and a specific gravity of 0.96. The weakest usually has a percentage of 5.5 and a specific gravity of .978. Ammonia has a powerful solvent action upon sulphur, is alkaline in its nature, and very volatile, so that much care is requisite in handling it. It has long been known to have a preservative effect upon India-rubber; for example, low grade African rubbers are often treated with Ammonia to neutralize the smell, and also to toughen the rubber. In the cold-curing process a saucer of Ammonia put in the bottom of the vapor room will effectually neutralize the fumes of chloride of sulphur. It is also advised to wash vulcanite that has begun to perish with an Ammonia solution. Soft rubber goods also are preserved, according to Dr. Pol, by the immersion for an hour in a solution made of 1 part of ammonia and 2 parts of water.

Sievier dissolved India-rubber in Ammonia, leaving it in a closed vessel for a long time, after which he heated the solution and distilled the Ammonia gas in cold water. Concentrated liquor of Ammonia is added to milk of the rubber tree to preserve it for transportation. Where vegetable fibers are reduced to cellulose and mixed with India-rubber, the rubber is first steeped in Ammonia and then dissolved in some suitable solvent. Newton mixed Ammonia with India-rubber and Gutta-percha, and then treated the gum with chlorine, making a white hard compound which he claimed would stand all varieties of climates, acids, greases, etc.

ANILINE.—A colorless oily liquid, manufactured chiefly from coal tar or nitrobenzine. It is a base from which the brilliant aniline dyes are made. Aniline, used by Parkes in the manufacture of Parkesine, is also a solvent for Gutta-percha.

ARSENATE OF POTASH.—It is a very soluble compound of arsenic with potash and forms what is known as Fowler's solution. In the dry state it is a white powder soluble in alcohol up to 4 per cent. Arsenate of Potash was used by Forster, among his earliest experiments, to partially vulcanize a compound made up of India-rubber and shellac.

BARIUM CHLORIDE.—A white crystalline powder, insoluble in

alcohol, but soluble in hot water, 78 per cent., and in cold 38 per cent. Its specific gravity is 3.05. It is not of great technical importance, its principal value being that of a test for sulphuric acid. To makers and users of sulphurets it affords a ready means of determining the presence of free sulphuric acid, so liable to occur in these bodies and so injurious to rubber compounds when present. A suspected sulphuret should be boiled for a moment with a little distilled water, the water filtered off, and a drop or two of a solution of Barium Chloride added; a white cloudiness that will settle in the form of a white powder proves the presence of sulphuric acid and such a sample should be rejected. Barium Chloride is a powerful poison. Used with size and acid resin as a shower-proof mixture.

**BISULPHATE OF POTASH.**—A white powder obtained as a by-product in chemical manufacturing. Soluble in twice its weight of cold water, and in half its weight of boiling water. It contains sulphuric acid so loosely held in combination that it is driven off upon heating. Its specific gravity is 2.16. (See Potash.)

**BICHROMATE OF POTASH.**—The principal compound of chromium, which occurs in the form of orange red crystals, that are soluble in water and are largely used in dyeing. Mixed with sulphuric acid, it is used in bleaching palm oil and other fats. Bichromate of Potash is used in vulcanizing the compound known as elastic glue; also used in Christia gums.

**BLEACHING POWDER.**—See Chloride of Lime.

**BORACIC ACID.**—This is found native in the vapor which arises from certain volcanic rocks, in a saline incrustation in volcanic craters and in combination with borax. It appears in the form of pure white leathery crystals. Boracic Acid is used with tungstate of ammonia, kauri, borax, and India-rubber in the production of the woodite fireproof compositions.

**BORAX OR BIBORATE OF SODA.**—Sometimes also called Tincal; a compound of soda and boracic acid. The purified commercial article contains about 47 per cent. of water of crystallization and is usually in the form of large odorless crystals, or a white powder obtained by grinding. The crystalline form has a specific gravity of 1.69. Borax is quite soluble in water, but not in alcohol or any of the common solvents for rubber. At a moderate heat



Borax loses water, and separates as a spongy mass called calcined borax, while at a higher heat it melts into what is known as borax glass. Immense deposits of it are found in the United States, and it is also found in India, Hungary, and other parts of the world. A good waterproof cement is made of a mixture of Borax and shellac boiled in water. Borax, or a solution of biborate of sodium, has the property of dissolving many resins. Lascelles-Scott describes the manner in which an emulsion of rubber may be preserved by a Borax solution. To a solution of rubber, in any one of the common solvents, a small portion of alcohol is added. This is mixed with a 2-5th saturated solution of Borax, previously heated from 120° to 140° F. This is agitated until the temperature has cooled down to the temperature of the air. From 3½ per cent. to 4½ per cent. of India-rubber should be present in the fluid when finished. A higher strength quickly separates and sometimes causes the entire quantity to coagulate. Madagascar or Sierra Leone rubbers are advised for Borax solutions. Solutions of borated rubber are adapted for waterproofing and for preserving mats, marine bedding, etc. Borax is also advised for preserving rubber milk from coagulation. It is also an important ingredient in the water varnishes used for luster finish, for surface coats, army blankets, etc.; is used in waterproofing compounds composed of rubber, boracic acid, kauri, tungstate of ammonia; mixed with Gutta-percha and shellac, it was used by Hancock as an insulating material.

CARBOLIC ACID, also known as Phenic Acid, is obtained chiefly during the destructive distillation of coal. The liquid has a hot burning taste, and is largely used for its antiseptic qualities. If white crystallized carbolic acid be added to the paste from which matrices in rubber stamp making are manufactured, it preserves the mixture for a long time. Carbolic Acid is used as a preservative of rubber milk, where it is coagulated by the process some time employed by the Orinoco Co., in Venezuela. Carbolic Acid has also been used in connection with a little ammonia to increase the elasticity of low grade African gums, being used as a solution before the gums are washed. It is also used for treating fabrics, such as hose linings for fire and mill hose, to

prevent deterioration and rotting. Used in certain fiber-made substitutes.

**CARBONATE OF AMMONIA**, obtained during the dry distillation of bones, is a white crystalline powder of very penetrating smell, from which quality it takes its popular name of smelling salts. Exposed to the air, it yields ammonia and absorbs water, becoming superficially converted into bicarbonate. It is used industrially for the removal of grease from cloth and cleaning woolen fabrics. Carbonate of Ammonia is used also in the manufacture of sponge rubber, and in hollow work, where its expansive force is utilized to effectually mold the article.

**CARBONATE OF SODA**.—Also called Sal-soda, washing soda. Prepared from cryolite, salt, etc. Its specific gravity is 1.45, when crystallized. The crystalline form contains 64 per cent. of water of crystallization, of which one-half is driven off by gentle heating. It is a white crystalline substance of alkaline taste. It is found in the ashes of many plants, is produced artificially in large quantities from common salt, and is used as an alkaline agent in many chemical industries. India-rubber, burnt umber, Japan, and a coloring matter are mixed with a certain proportion of Salsoda for a waterproofing composition. Under the common name saleratus, Carbonate of Soda is used as follows: Instead of sunning surface goods, like rubber coats and blankets, they are often brushed over with a mixture of saleratus and powdered charcoal right after the stock leaves the calender. Sometimes the saleratus is left out and only charcoal is used.

**CAUSTIC SODA**.—The chief use of this, in the manufacture of rubber goods, is in the dissolving of sulphur that is formed on the surface of goods, and which is known as bloom. According to H. L. Terry, F.I.C., the bulk of the alkali supplied to rubber manufacturers in England is used in removing the sulphur from elastic thread. Of course it is used in treating tobacco pouches, fine sheet articles, and blacks, reds, or maroons, that should have a good clear color. The boiling of rubber goods is usually done in wooden tanks in which steam can be passed, and sometimes in slate tanks, as iron is attacked by the alkali. On good grades of rubber caustic soda has no action at all; where a large quantity of resin is present, however, it may dissolve some of them, forming

resinates of soda. Heavily compounded rubbers, whether they contain substitutes, gums, or compounds, unless they are absolutely inert, are also liable to be attacked through the dissolution of their ingredients. Camille describes a process whereby shoddy is treated with a solution of carbonate of soda in devulcanization. In this, the rubber is boiled several hours in a solution of caustic soda, the result being that it will sheet when the process is completed. Rostaing purified Gutta-percha, by boiling in caustic soda, or in a mixture of caustic soda and potash in water.

CATECHU, or CUTCH.—Known formerly as Japan Earth. Made from the sap of an East Indian tree, and used chiefly in dyeing. Is very astringent, and is soluble in water. It appears in commerce in dark brown irregular lumps. Contains 40 to 50 per cent. of a peculiar tannic acid. Used in packings and goods made from the whaleite formulas. Johnson's artificial leather was made of Catechu, rosin oil, linseed oil, turpentine, and starch, mixed with a little hot Gutta-percha. A number of other compounds, both with and without India-rubber, contain Catechu, but chiefly those which were compounded from gelatine, starch, and gluten. Catechu is mixed with Gutta-percha in solution in order to make it harder.

CAUSTIC AMMONIA.—See Ammonia.

CAUSTIC POTASH.—As occurring in commerce, it is a white solid substance of the specific gravity about 2.5. It is hard and brittle, and very destructive to animal or vegetable substances. It rapidly takes up water from the air, and may be used to obtain a dry atmosphere in a confined vessel. It is also a greedy absorbent of carbonic acid, becoming converted into the carbonate thereby. Solutions of potash should be clarified by allowing impurities to subside. Its taste is bitter and acid and its smell unpleasant. Alcoholic Caustic Potash is used in analysis of vulcanized India-rubber and was introduced by Henrichs, particularly to separate India-rubber from India-rubber substitute. Caustic Potash is mixed with flowers of sulphur for boiling drawing rolls, the potash making the rubber more solid, while the sulphur gives a peculiar surface, making it better for drawing. Used in water solution to remove bloom from cured rubber. It is also used in certain substitutes for hard rubber, like voltit. Potash

was early used in extracting the sulphur from ground vulcanized rubber. A percentage of it is used to-day in neutralizing the acid used in the chemical recovery of rubber.

**CHLORIDE OF AMMONIUM.**—Also known as Muriate or Hydrochlorate of Ammonia, or Sal-ammoniac. Obtained largely from gas works. Specific gravity 1.5. Usually occurs in small crystals of a sharp, saline taste. When dissolving in water a considerable reduction of temperature occurs, and this has rendered it valuable for cooling purposes. At temperatures above 212° F. it is completely evaporated, and a decomposition occurs into ammonia and muriatic acid. It is used in certain packings in which iron filings are incorporated.

**CHLORIDE OF CALCIUM.**—A crystalline substance containing about 50 per cent. of water of crystallization, which is lost on heating to 392° F. The specific gravity is 1.61, and that of the dried form 2.21. Its extreme attraction for water makes it useful in obtaining a dry atmosphere in any closed receptacle. Its color is white, taste acid and sharp. It absorbs ammonia readily and will give it up again on heating. It is used in bookbinders' cements.

**CHLORIDE OF LIME.**—Sometimes called bleaching powder, although this latter is a mixture of the chloride and hypochlorite of lime. Industrially, its chief use is for bleaching purposes, dependent upon the amount of chlorine it contains. Commercial bleaching powder is a white powder with a faint smell of peculiar character and gradually becoming moist on exposure to the air, while it gradually decomposes and absorbs water and carbonic acid. Even in closed vessels decomposition occurs, and sometimes so suddenly and with such a rise of temperature that explosions occur. Hence it should always be used fresh and a guarantee obtained from the vendors (as is customary) of the quality of the article. Chloride of Lime is the basis of a cold curing process known as Caulbry's (which see). Gutta-percha boiled in it and then mixed with rosin and paraffine is used in insulation.

**CHLORIDE OF SODIUM** (or common salt) has a specific gravity of 2.3. It is a very stable compound, soluble in water at the ordinary temperature to the extent of 36 per cent., at the boiling point 39 per cent. At the freezing point water will take up  $5\frac{1}{2}$



per cent. of common salt. It is used, as is well known, in coagulating many of the rubber latexes. Salt is viewed with considerable distrust by ordinary manipulators of rubber. Payne, however, treated Gutta-percha scraps by boiling water, salt, and oil of vitriol, to get a solution to which he added other gums and metallic oxides to get a waterproofing mixture. Cooley made artificial leather of Gutta-percha dissolved in rosin oil, and added 25 per cent. or more of salt, to which he added starch or other saccharine substances. Salt, in the form of brine, is used in washing the compound known as tremenol as a last process. It is also used in shower-proofing compounds, in connection with paraffine and sulphuric acid.

CHLORIDE OF ZINC was known formerly as Butter of Zinc. It is formed by burning zinc in chlorine gas, or by dissolving it in hydrochloric acid, the solution being evaporated. The anhydrous form is a whitish gray mass which readily fuses, and can be sublimed at a high temperature. It deliquesces on exposure to the air, and is readily soluble in water, the solution having a bitter taste, and acting in a concentrated state as a powerful caustic. One of the best processes ever known for reducing the fiber in recovering rubber was that in which this substance was employed instead of acid. A boiling solution of Chloride of Zinc was used in deodorizing by Brockedon, who also mixed it with Gutta-percha, adding sulphur and vulcanizing the gum. Hancock also subjected Gutta-percha for a moment or two to binoxide of nitrogen, then immersing it in a boiling solution of chloride of zinc, which he claimed greatly improved its quality.

CHROMIC ACID is not readily obtained in a free state, but forms many well-known salts, such as chrome yellow, for instance. It is analogous with sulphuric acid. Vulcanized rubber immersed in it at 140° F. remained a month, and was apparently unharmed. It is also used in the manufacture of the substitute known as corkaline.

CITRIC ACID.—An organic acid that occurs in lemons, limes, and many other fruits. It is readily soluble in water, and has an intensely sour taste. Has been used in the coagulation of Balata. Vulcanized rubber immersed in it at 140° F. remained a month, and was apparently unharmed.

**CREAM OF TARTAR.**—A white crystalline substance with an acrid taste, a very common ingredient in baking powders; also called Potassium Bitartrate. It is made from purified tartar, or argol. It is used in artificial ivory made from resins in solution.

**CRYSTALS OF SODA.**—See Carbonate of Soda.

**CYANIDE OF POTASSIUM.**—A white crystalline substance, very poisonous, of a sharp bitter taste. It is very easily decomposed, even on exposure to the air absorbing carbonic acid and yielding prussic acid, which gives the salt its peculiar smell of peach kernels. The vapors thus given off are very poisonous. Cyanide of Potassium was used by Brooman "to give clearness to the gum which was made from ground vulcanized rubber, which had been treated with alkalies and acids to remove sulphur and adulterants."

**FLUORIDE OF SILICON** is a colorless gas. What is used in the arts is a solution in water, forming a very sour fuming liquid, acting like a strong acid. It is easily decomposed and may be used for etching glass if allowed to evaporate upon it under heat. It is prepared from flints or silica in some such form as sand or powdered glass. Used in treating meerschaum and paper pulp which, combined with certain resins, forms an artificial ivory.

**FORMIC ACID** obtains its name from the fact that it was first obtained from the red ant. It is a fuming liquid with a pungent odor, boiling at  $212^{\circ}$  F. It is now made from a mixture of starch, binocide of manganese, sulphuric acid, and water. It has been suggested as an ideal precipitant for rubber milk. It is quite volatile, could be easily washed out, and would be found more beneficial to the rubber than many of the alkaline solutions now used.

**HYDROCHLORATE OF AMMONIA.**—Another name for Muriate of Ammonia or Sal-ammoniac. (See Chloride of Ammonium.)

**HYPOCHLORITE OF LIME.**—One of the principal constituents of bleaching powder. It does not exist alone. (See Chloride of Lime.)

**HYDROSULPHURET OF LIME.**—Lime that has been treated with hydrogen sulphide. It is an offensive smelling substance, of a dirty greenish gray appearance, and is obtained in the process of purifying coal gas. It decomposes easily, giving off sulphureted hydrogen. It will absorb bisulphide of carbon and is solu-

ble in alcohol. Its liability to oxidize should render it of questionable use in compounding. It was used by Hancock in vulcanizing India-rubber.

HYDROCHLORIC ACID is known usually by its trade name of Muriatic Acid. It is also known as chlorhydric acid, and spirits of salt. It is one of the principal mineral acids. Used in the arts in the form of a water solution, of which the strength varies from a specific gravity of 1.01 or 2° Beaume with 2.02 per cent. acid to 1.21 or 26° Beaume, with 42.85 per cent. acid. Each .01 increase of gravity corresponds to 1° Beaume and 2.02 per cent. of acid. It is corrosive to the skin and attacks nearly all metals. It has no action on caoutchouc and very little on oxidized linseed oil if the acid be dilute. With soda and its compounds generally speaking it will form common salt and with metals it forms chlorides thereof. Hydrochloric Acid, during the treatment of reclaimed rubber, turns whiting into chloride of lime. As the chloride is more soluble than sulphate of lime much of it washes out during the vigorous cleansing that the rubber undergoes to remove the free acid. Hydrochloric Acid, according to tests made by William Thompson, F.R.S., did not at all injure India-rubber, although it was kept in it at a temperature of 140° F. for a month. Concentrated Hydrochloric Acid has but little action on Gutta-percha, and tubing made from it is therefore largely used in chemical factories for running this acid from one vessel to another. Hydrochloric Acid is used in the manufacture of turpentine rubber, and in one of the last processes in the analysis of vulcanized India-rubber. In preparing a hard rubber compound, Austin G. Day used linseed, cottonseed, castor, and coal oils; hydrochloric and nitric acids; bicarbonate of soda, muriate of tin, coal tar asphaltum, sulphur, and Gutta-percha.

IODIDE OF ANTIMONY.—A brownish red crystalline mass, which yields a cinnabar red powder. It is soluble in hot carbon bisulphide. Its specific gravity is 4.39. It was used by Parkes in vulcanizing India-rubber.

IODIDE OF ZINC.—A very unstable substance. A white granular powder, odorless and of sharp, saline metallic taste. Chiefly used in medicine. It was used by Hancock to assist in the vulcanization of India-rubber.

LIQUOR OF FLINT.—See Silicate of Soda.

MIMO-TANNIC ACID.—See Catechu.

MURIATE OF AMMONIA.—See Chloride of Ammonium.

MURIATIC ACID.—See Hydrochloric Acid.

NITRATE OF LEAD.—A compound of lead and nitric acid containing 62.5 per cent. of lead. Its specific gravity is 4.58. It has an astringent metallic taste, crackles when heated, detonates when thrown on red hot charcoal, and takes fire when ground with sulphur. Its color is white and it is largely used in dyeing and for making chrome yellow (which see). It is used with gums in the production of shower-proof mixtures with sugar of lead and alum.

NITRIC ACID.—Chemically an oxide of nitrogen. Technically a strongly acid liquid consisting of an aqueous solution of the pure acid. Its action on different bodies is various. Some, like sulphur, phosphorus, carbon, and many organic substances are easily oxidized. Tin and powdered antimony are rapidly converted into their oxides, while turpentine, if poured into the strong acid, is attacked with almost explosive violence with the evolution of light and heat. Straw or sawdust may become ignited if impregnated with this acid. Cotton wool is converted by it into gun cotton. Rubber immersed in Nitric Acid at a temperature of 140° F. was injured in a few hours, and in a few days its elasticity was destroyed, while at the end of the month it was reduced to a pulp. Nitric Acid attacks Gutta-percha very powerfully, and evolves suffocating fumes of a deep red color, the gum meanwhile being reduced to a pasty mass which afterwards dries and becomes very brittle. According to H. L. Terry, F.I.C., Nitric Acid of any strength has a very deleterious effect upon India-rubber, the action of the fuming acid being to form immediately an oxidized body of a resinous nature. He holds, therefore, that the weaker acid also injures the India-rubber, although of course in a less degree. Nitric Acid is used in the treatment of leather cuttings to reduce them to a glutinous mass before being mixed with India-rubber, and is also used in making certain substitutes.

NUT-GALL.—An excrescence formed on the leaves of a species of oak called *Quercus infectoria*. It is used in the arts for the sake of the tannic acid it contains. There are three varieties in



commerce—green, white and black. The black and the green are the best. Those grown in warm countries are the best. Aleppo galls contain from 60 to 66 per cent. of tannic acid. There is a variety of nut-gall known as Chinese, imported from Japan, China, and Napal. The gall is somewhat bean-shaped or is covered with a yellow gray felt. It contains from 60 to 70 per cent. of tannic acid. Nut-gall is used in certain places instead of tannin, which see.

OIL OF VITRIOL.—See Sulphuric Acid.

OLEIC ACID.—An acid found in certain animal and vegetable oils, such as olive oil, sperm oil, etc. It has been used in certain substitutes for hard rubber, like voltit, and by Hunt for recovering waste vulcanized rubber under heat, methylated spirit being added later to precipitate the rubber, which was then washed in a weak caustic soda.

OXALATE OF LIME.—Quick lime slaked by water in which is oxalic acid is given this name. Used in certain Gutta-percha compounds.

OXALIC ACID occurs in transparent, colorless prisms, with a very sour taste, soluble in both cold and hot water. It is produced by either the action of the hydrate of potash, or of nitric acid upon most organic compounds. It is very poisonous. Gutta-percha was cleansed by Lorimer's process by boiling in water mixed with this acid.

PERMANGANATE OF POTASH occurs in dark red prisms of a greenish color which, when dissolved in water, give a purple red. It is a decided oxidizer, and is used as a disinfectant. It is also called chameleon mineral. Used in certain artificial leathers.

PEROXIDE OF HYDROGEN.—This is a powerful oxidizing agent, largely used as a bleaching agent, and also as an antichlor for use after chlorine bleaching. It comes in the form of a colorless liquid, and has a specific gravity of 1.45. Neither the alkaline nor the acid solutions of this reagent seems to impair vulcanized India-rubber. In certain cases Peroxide of Hydrogen has been used in removing the bloom from rubber, which it does most effectively; besides, it seems to penetrate the surface of the rubber and dissolve the sulphur. It also has a curious effect on colors, brightening some reds wonderfully, dulling others, and

rendering whites much whiter. One curious effect that it has upon India-rubber is to bring out any surface imperfections in a marked degree.

**PHOSPHATE OF SODA.**—A crystalline colorless substance containing 60 per cent. of water, which is given up on heating to  $248^{\circ}$  F., leaving behind a dry mass. The commercial article frequently contains sulphate of soda as an impurity. The crystals have a specific gravity of 1.5, melt at  $95^{\circ}$  F., and are readily soluble in water. By long drying at  $113^{\circ}$  F. the water of crystallization may be entirely driven off. The presence of this material is called for in a certain compound for dental vulcanite, where it is incorporated with rubber, sulphur, and phosphate of lime, the idea being that less sulphur is required than in the ordinary compounds.

**PHOSPHORIC ACID.**—See Phosphorus.

**POTASH.**—This substance, a carbonate of potassium, is usually met with commercially in small colorless crystals. It is prepared in a variety of ways and forms, the basis from which is prepared what is called caustic potash. Pearl ash is a crude form of potash mixed with the caustic variety and a sulphuret of potassium. Used in certain proofing compounds where low heat is required for cure. It was used by Charles Hancock, mixed with water in a bath, to improve the quality of Gutta-percha. He found, by boiling the Gutta-percha in such a bath for an hour, that it did not oxidize in the open air as badly. An old-fashioned process for treating unvulcanized thread was to steep it in a hot solution of carbonate of potash, which greatly increased its strength. (See Caustic Potash.)

**QUICK LIME** is the impure oxide of calcium obtained by heating or burning chalk, marble, or limestone, or any carbonate of calcium. Its well-known attraction for water renders it unstable but also valuable where dyeing qualities are desired. Blizzard claimed to be able to make a perfectly transparent rubber by treating it with soda and water, in which was a little Quick Lime.

**RECLAIMING SALT.**—An alkaline composition made in Germany and used chiefly in the reclaiming of red and light colored rubber waste.

**RENNET** is made from the inner lining of the true stomach

of the sucking calf and gets its value from the gastric juice contained therein. The membrane, after treatment, is salted and stretched out to dry. It is advised in the Vaughn process for coagulating Balata.

**SALICYLIC ACID** is obtained from the creeping plant known as wintergreen. It is prepared from the oil of wintergreen (oil of Gaultheria), which is distilled in large quantities in Luzerne county, Pennsylvania. It is soluble in the following proportions: 1 part of the acid dissolves in 450 of water, or 2.4 of alcohol. It melts at 312° to 314° F. Salicylic Acid was used in an artificial leather compound for reducing leather dust to a paste, after which it was mixed with glue under heat, and treated to an alkaline solution.

**SAL AMMONIAC.**—See Chloride of Ammonium.

**SALT.**—See Chloride of Sodium.

**SALTPETER** is niter or potassium nitrate. It is a crystalline substance, white, and having a saline taste, and is a very strong oxidizer. It is used in the manufacture of artificial elaterite. In Gridley's process for recovering rubber, by exposing it to flame, saltpeter was added to remove the smell.

**SALERATUS.**—See Carbonate of Soda.

**SAL SODA.**—See Carbonate of Soda.

**SILICATE OF SODA.**—See Soluble Glass.

**SOAPS.**—Various kinds of soaps are used in rubber manufacture. Pure Castile soap, for instance, is dissolved in rain water and made into a soft soap that is used to "slick" molds that the rubber, during vulcanization, may not adhere to them. Some manufacturers use by preference white soda soap made from caustic soda and olive oil. Resin soaps are also used in certain shower-proof compounds. A further use for soap is in the manufacture of water varnishes for luster coats and blankets. A soap compound for wagon covers is made of 50 pounds of soap dissolved in 15 gallons of water, heated to 250° F., to which is added 25 pounds of sulphide of zinc. A half pint of rubber dissolved in olive oil by heat is added to each gallon of the above mixture. Whiting, lampblack, or coloring matters may be added. Vulcanized rubber, beeswax, rosin oil, argillaceous earth, and alkaline soap form the basis of Sorel's substitute for rubber.

SODA.—See Carbonate of Soda.

SODIUM HYPOSULPHITE.—A 1 per cent. solution is used for removing traces of chlorine where its presence is suspected in India-rubber.

SOLUBLE GLASS (known also as Waterglass) is a silicate of soda or potash. It is usually sold in solutions of varying density, the commonest being 33° and 66°, by which is meant that the solution contains either one-third or two-thirds solid waterglass. Acids readily precipitate the silica from these solutions as a gelatinous mass. It is used in certain shower-proof compounds and in compounds of the Algin (which see) type.

STEARIC ACID.—See Stearine.

SUGAR OF LEAD.—This is used in certain rainproof compounds, one of which is 16 parts of compounded rubber, 128 parts of paraffine wax, 1 part of Sugar of Lead, 1 part of alum in powder. India-Rubber compound contains no sulphur. Used also in artificial rubber and artificial ivory. (See Acetate of Lead.)

SULPHATE OF ALUMINA.—The active principle of alum. Often sold as concentrated alum. Occurs commercially as white square cakes, somewhat transparent, and capable of being cut with a knife. Readily soluble in water, and contains a small quantity of free sulphuric acid, potassa, and soda alum. Its specific gravity is about 4; water of crystallization 48 per cent. Its composition indicates a usefulness in compounding sponge rubbers. Used in linseed oil compounds, for wagon covers. (See Alum.)

SULPHATE OF COPPER.—Sometimes called Blue or Cyprus Vitriol. Occurs in commerce in masses of large blue crystals having a specific gravity of 2.28, and containing 36 per cent. of water of crystallization, and a varying additional percentage of entangled moisture. Heated for some time at 212° F. all the entangled water may be driven off, together with four-fifths of the water of crystallization, the residue being a bluish white powder. Sulphate of Copper is used in attaching rubber to iron during vulcanization.

SULPHATE OF SODA occurs commercially in colorless crystals which deteriorate in contact with the air, and hence should be



kept in well closed vessels. It contains a very large amount—nearly 60 per cent.—of water of crystallization, which is yielded on heating to 302° F. Its reaction is alkaline. Sulphate of Soda was used by Hancock in vulcanizing Gutta-percha.

SULPHURIC ACID (called also Oil of Vitriol), when pure, is a colorless oily looking heavy liquid of a sharp, sour taste. It is very corrosive, and has a great attraction for water; hence wood and other organic bodies are charred by its depriving them of their water. The specific gravity of the commercial acid is usually about 1.83, or 66° Beaume, containing 94 per cent. of acid. Sulphuric Acid is used in the coagulation of Madagascar rubber. The Orinoco Co., in Venezuela, are also said to have coagulated India-rubber by mixing the milk of the *Hevea* with sulphuric and carbolic acid. Commercial Sulphuric Acid is said to coagulate 55 times its volume of gum, while the carbolic acid acts as an antiseptic in the juice, improving its keeping qualities. It is a question whether rubber treated this way is as good as that obtained by the smoking process. Rubber immersed in Sulphuric Acid at 140° F. remained a month and came out stronger, apparently, than when it went in. Sulphuric Acid is used in paste blacking, mixed with boneblack, vinegar, molasses, and caoutchouc oil. Concentrated Sulphuric Acid colors Gutta-percha brown, throwing off at the same time sulphurous acid fumes. Nevertheless, a paste of this acid and charcoal was added by Hancock to Gutta-percha to make it pliable. Sulphuric Acid may be expected to attack vulcanized rubber compounds in which there are large proportions of chalk, lead, or zinc oxides. Sulphuric Acid is very largely used in destroying the fiber found in ground waste rubber; indeed it is the basis of what is known as the acid reclaiming process. When thus used the acid turns whiting into sulphate of lime.

TANNIC ACID.—See Tannin.

TANNIN includes a number of substances, some of which are crystalline and others amorphous, with a marked astringent taste, and no smell. The solutions are acid, soluble in water and alcohol, and yield precipitates with most metallic oxides. It is the active principle of oak bark, hemlock bark, catechu, and many other materials usually used for tanning hides. Pure Tannin is

a light powder of a yellow greenish hue, soluble in water, alcohol, and ether. Its solution precipitates glue. It is used with sulphate of alumina, waterglass, and glue in shower-proofing. Tannin has been claimed to be injurious to rubber, the reason being that rubber thread used in gorings is often destroyed at points close to its junction with the leather. It is more likely, however, that it is the oil or oleic acid that effects the destruction. Tannin was largely employed by Austin G. Day in many of his "Kerite" compounds with excellent effect. It is also used in the manufacture of certain puncture fluids, together with glue and glycerine.

TARTARIC ACID is found usually in the form of transparent colorless prisms, which have an agreeable acid taste, are not affected by the action of the atmosphere, and are soluble in either alcohol or water. Nitric acid or peroxide of lead act upon Tartaric Acid, turning it into formic and carbonic acid. This acid is very abundant in the vegetable kingdom, being found in many fruits. Used under Vaughn's patent in coagulating Balata. Vulcanized rubber immersed in Tartaric Acid at 140° F. remained a month, and was apparently unharmed.

TUNGSTATE OF AMMONIA.—A crystalline body which is very soluble in water and becomes covered with a white bloom on exposure to the air. Used with boracic acid, kauri, borax, and rubber in the production of the woodite fireproof compositions.

TUNGSTATE OF SODA.—Prepared commercially from wolfram ore and soda ash; usually contains about 14 per cent. water of crystallization; and is in the form of colorless crystals. Mixed with a solvent such as methylated ether, it is added to soluble gun cotton, castor oil, and gum copal, forming a substitute for India-rubber.

TUNGSTIC ACID is derived chiefly from wolfram, which is a tungstate of iron and manganese. Tungstic Acid is analogous to sulphuric and chromic acid. It has been used in connection with paraffine, gelatine, and metallic oxides in proofing compounds.

## CHAPTER XI.

### VEGETABLE, MINERAL, AND ANIMAL OILS USED IN RUBBER COMPOUNDS AND SOLUTIONS.

THE use of oils in the rubber manufacture has kept pace fully with the use of gums, substitutes, and reclaimed rubber. The addition of earthy or metallic or vegetable ingredients in dry mixing has rendered many a good rubber somewhat intractable—a fault which the right oil has often rectified. As a rule, vegetable oils are chosen, as they are rarely harmful to the gum. Many mineral oils are also freely incorporated in certain compounds. Animal oils have always been viewed with more or less suspicion, however, and with good reason, for manufacturers have constantly before them rubber goods that have lost their life and elasticity through contact with lubricants made of such oils and fats. Nevertheless certain of them may be and are used. The essential or volatile oils are used to a certain extent in rubber manufacture. These oils, as a rule, are liquids which give the peculiar odors of plants from which they are derived. Their use in rubber is to impart to it a pleasing odor.

**ALUMINUM LANOLATE.**—This is a product of French Wool Grease (which see), made by adding a solution of alum. After the addition of the alum, it falls in a brown precipitate. It is then dissolved in mineral oil, forming a jelly-like mass which is said to compound readily with either India-rubber or Gutta-percha, and is soluble in any of their solvents. It is possible that this may have some both softening and preservative influences on India-rubber, as is claimed, but it should be used with considerable caution.

**ANHYDROUS PARAFFINE OIL.**—Water-free paraffine oil (which see).

**BIRCH OIL.**—The fine white bark of the birch tree yields a red oil, nearly one-fourth of which consists of the sap phenol, which gives the well-known odor to Russia leather. The residue, or green part of the birch, yields neither acid nor alkaloid, and forms with alcohol a fluid solution which, when once dried, is unacted on by alcohol. It is chiefly obtained from northern

Europe and Siberia, and has recently been made also in Germany and Austria, where it is known as Jackten oil. This substance will unite with the most brilliant colors, and has been used in France for waterproofing textile fabrics. In connection with shellac, resin, and aniline, it is used in the form of a substitute for Gutta-percha in insulation.

**BLOWN OILS.**—These are prepared by heating fixed oils in a jacketed kettle and blowing a current of air through the fluid. Under this treatment, oils become much more dense and also viscous; indeed, in many physical aspects, they resemble castor oil, but differ in that they can be mixed with mineral oils and as a rule are not easily soluble in alcohol. Blown oils made from linseed oil, rape oil, poppyseed oil, and cottonseed oil are sometimes used in the manufacture of rubber substitutes instead of the raw oils. Known also as Thickened Oils, Base Oils, Soluble Castor Oil, etc.

**BONE OIL** is obtained by the distillation of animal gelatinous substances, principally in the calcining of bones for the preparation of boneblack. Its specific gravity is 0.97. It is sometimes called Dippel's Oil (which see).

**CAMPHOR OIL.**—A liquid of a light reddish brown with a yellowish tint, a strong odor like camphor, and a bitter camphor-like taste. Its specific gravity is 0.94. Japanese oil varies in color from colorless through pale straw, yellow, to black, and has a specific gravity of 0.898 for the colorless to 0.99 for the very dark. This oil is used in the manufacture of celluloid varnishes, paints, lampblacks, etc. It is used also as an adulterant for such oils as sassafras oil. It is one of the best solvents for resins, and dissolves 46 per cent. of rosin, 9 per cent. copal, and 35 per cent. of mastic.

**CAOUTCHOUC OIL.**—Made by digesting 55 parts of India-rubber in 450 parts of linseed oil. The principal large use for this oil is in Germany, particularly in the army, where it was used for coating various articles to prevent their rusting. The following substances are found in Oil of Caoutchouc: Eupoine, butylene, caoutchoucine, isoprene, caoutchine, and heveene.

**CASTOR OIL.**—A colorless or pale greenish transparent oil, very viscous and thickening on exposure to the air. It has the



highest specific gravity of any known natural fatty oil—0.958. It is adulterated frequently with resin oil and rape, linseed, and cottonseed oils, especially the "blown" variety. Used in cheap proofings without rubber with Kauri gum; also in collodion and rubber proofing. It is used in the production of substitutes like gum fibrine, and also with chloride of sulphur in producing amber-colored substitute.

CHOLESTERIN.—See Lanichol.

COD OIL or COD-LIVER OIL is obtained from the livers of codfish. Newfoundland and Norway are the principal manufacturing points. The finest is a very pale, clear, golden yellow, the color deepening to a brown in the second and third grades. Its specific gravity is 0.923 to 0.929. One part of oil is soluble in from 40 to 20 parts cold alcohol, or 30 to 17 parts hot alcohol. The lower grades are the more soluble. It is much adulterated. Is compounded with India-rubber, beeswax, linseed oil, litharge, and asphalt as a waterproofing for leather and with India-rubber, beeswax, and turpentine as a dressing for hides.

COLZA OIL.—See Rape Oil.

CONSOLIDATED OIL.—See Stearine.

CORN OIL (also known as Maize Oil).—Made from the seed of Indian corn, the plant known botanically as *Zea mays*. There are two processes of manufacture: (1) in which the seed germ is pressed before it is used for the manufacture of starch, which produces oil of a golden yellow color, and (2) where it is recovered from the residue of the fermentation vats where the corn has been used in the production of alcohol. This oil is dissolved sparingly in alcohol, but very readily in acetone. The oil is almost without drying powers. Neither boiling nor the addition of lead when boiling gives it definite drying properties. If it is heated, however, and a current of air passed through it, and manganese borate mingled with it, it dries after a fashion. It is largely used at present in the manufacture of what are known as Corn-oil substitutes.

COTTONSEED OIL is made from the seeds of the cotton plant, usually the *Gossypium herbaceum*. The crude is of a ruby red almost black color. The refined is pale yellow and possesses a pleasant nutty taste. It is a semi-drying oil, and is rarely adul-

terated except when linseed oil is very cheap. On standing it deposits stearine in waxy flakes. Much used in making substitutes for rubber. It is also used in the production of artificial elaterite, and with paraffine oil for canvas proofing. For Cotton-seed blown oils see Blown Oils.

CREOSOTE OIL is a distillate from wood tar. It is an oily liquid with a smoky taste, and is antiseptic. It should be colorless but is usually yellow or brown, due to impurities or to exposure. The best is made from the beech. A similar oil is distilled from coal tar. Mixed with red oxide of mercury it has been used to coat the fabric of which cotton hose is made as a preservative; with India-rubber and sulphur it has also formed an insulating compound for telegraph wires. It is used in some rubber works where it is arranged that the fumes of the naphtha are carried off into it, which it rapidly absorbs, to be later recovered by distillation.

ESSENCE OF PETROLEUM.—Obtained during the refining of Petroleum, and known also as petroleum, vaseline, petroleum jelly, etc. (See Vaseline.)

EUCALIPTIA.—A fragrant, refreshing volatile oil. It is prepared from eucalyptus oil.

EUCALYPTUS OIL.—An aromatic oil found in the leaves of the *Eucalyptus globulus* in Australia. The odor of the oil is extremely pleasant, smelling not unlike oil of verbena. This oil is said to be most advantageous, used in small quantities in connection with solvents for India-rubber, as it tends greatly to accelerate complete solution. It also breaks down refractory samples of the gum and renders all of the compound homogeneous. It is said that one-third of the time may be saved if from 4 to 6 per cent. of this oil is used in the solvent. It is especially good for low-grade gums. It has also great solvent power on all resins and gums, including India-rubber and Gutta-percha. With the addition of a little methylated spirit it will dissolve even kauri gum, cold. It is also used in dissolving asphalt for photograph varnish.

FISH OIL.—Obtained from all parts of the bodies of common fish by boiling. Fish whose livers yield oil commercially do not give Fish Oil, and those bodies that yield oil, do not give liver

oils. Principally prepared from Menhaden. Its specific gravity varies between .915 and .930. Fish Oil is used in the manufacture of the substitute known as volenite. It is used, however, only as a vehicle for carrying resin into the fiber, being afterwards wholly removed.

FRENCH WOOL GREASE.—See Lanoline.

GLYCERINE.—A clear liquid of oily sweet taste, without odor. When pure it has a specific gravity of 1.26. The Glycerine of commerce is a by-product of the soap manufacture, chemical reaction occurring when the fat is treated with a caustic alkali, giving rise to a compound of a fatty acid and alkali to form a soap, while the Glycerine is at the same time liberated and goes into solution. Glycerine is not acted upon by oxygen, and therefore more closely resembles mineral oils, such as are used in rubber mixing, than it does the drying oils that go to make up substitutes. It has absolutely no solvent action on rubber.

A recent German patent calls for the addition of Glycerine because of its oil resisting qualities. In the compound used are 6 pounds of rubber, and 1 pound of Glycerine, together with whitening, litharge, and sulphur. A soap made of Glycerine and an alkaline fluid is also used as a cleaning and polishing medium in the last stages of the manufacture of certain cut sheet goods. Glycerine combined with gelatine and borax has been used as a wash for both black and red rubber surfaces.

Glycerine was the basis of a well-known deodorizing composition for India-rubber, the other ingredients being of an alkaline nature. A bath of Glycerine has also been used for experimental work in vulcanizing India-rubber, and also for rubber stamp making. In this kind of work, the mold and its contents are immersed in the Glycerine so that the liquid just covers the top of the mold; heat is then applied to the Glycerine, and the mold in turn becomes hot and the rubber vulcanizes. It is also used to a certain extent in good grades of white rubber, as it gives a softened effect to the compound. Glycerine, in connection with glue, gelatine, molasses, and tannin, is used in the manufacture of puncture fluids for tires. It is also used in clothing compounds, and in cellulose products like pegamoid. Used in rubber, a little

of it increases the resiliency of the product. Another use for Glycerine is to prevent fabrics from mildewing. The fabric is coated with it before being frictioned.

HYDROLENE.—A rubber assistant used in connection with the reclaiming of rubber, and also rubber compounding. It would seem to be a petroleum product, and in rubber reclaiming is used instead of stock oil or residuum.

JAPAN WAX.—A white or pale yellow vegetable fat, with a specific gravity of 0.97 to 0.98. It is used in wax matches, candles, and for adulterating beeswax. A special use for it, that has arisen within the last few years, is in the manufacture of cravenette cloths.

LALLEMANTIA OIL is obtained from the seeds of the *Lallemantia iberica*, a plant cultivated in Russia. This is one of the best drying oils, being said to surpass even linseed oil, but its chief use is for illuminating purposes. In Europe it is said to have been used instead of linseed oil in rubber substitutes.

LANICHOL.—A product of lanoline (which see), made from the oil of sheep's wool. It combines with Gutta-percha and India-rubber in any proportion to a perfectly homogeneous mass. This grease does not oxidize and is wholly antiseptic. It has no smell, and is impervious to the action of alkalies or to dilute sulphuric acid. It is said that, used in connection with Gutta-percha, the melting point is considerably raised, while it does not diminish the insulating property. An insulating compound given is 50 parts by weight of Gutta-percha, 30 parts of India-rubber, 20 parts Lanichol. The inventor claims that it renders Gutta-percha less liable to oxidation, improves its elasticity and tenacity, and diminishes its liability to become sticky. Patented in the United States and Great Britain by Robert Hutchinson.

LANOLINE is also known as wool grease, recovered grease, and brown grease. It is the natural grease found in sheep's wool and recovered from it while the raw wool is being prepared for spinning. A similar grease, made from scoured woven goods, is known as Yorkshire grease. It is a thick yellow or brown offensive smelling greasy paste. Commercial Lanoline is lighter colored and consists of about 80 per cent. of pure wool fat and 20 per cent. of water. It possesses in a remarkable degree the



property of taking up water without losing its vaseline-like consistency. Is largely used in ointments.

Lanoline, mixed with India-rubber, works up into an exceedingly sticky mass, and is used as a medicinal plaster. It is said that, while it possesses the adhesive properties of the regular plaster, Lanoline takes up the medicament, and while very sticky can be readily removed from the skin. It is used for the purpose of softening India-rubber, and was advised for use in tires, as it was said to soften the compound, and to keep the tire from decay, and from consequent surface cracking. It was also said to be used in boot and shoe work.

LARD OIL is prepared by the cold pressing of lard, which, of course, is the fat of the hog. It is a colorless, limpid liquid, although poorer grades are brown. Its specific gravity is 0.915. It is frequently adulterated with rape oil and cottonseed oil. Lard Oil, mixed with powdered pumice stone into a thick paste, is used for polishing hard rubber.

LINSEED OIL is pressed from the seeds of the flax plant (*Linum usitatissimum*), grown chiefly in India, Russia, and Argentina. The trade recognizes two qualities of Russian seed—yielding the Black sea Linseed Oil, and the Baltic Linseed Oil—while that coming from India is known as East India Oil. Of these, the Baltic is the best, and the East Indian the poorest in quality. The two lower grades are not up in quality for the reason that the Black sea seed contains a certain amount of hemp seed, while that from India is usually mixed with rape, cameline, and mustard seeds. The oil which is expressed from these seeds is of a golden yellow color, with a peculiar taste and odor. Linseed Oil becomes easily rancid in the open air, but when spread in thin films dries into an insoluble substance which has been called linoxyn. Linseed Oil is adulterated sometimes by fish or mineral oils, and by resin oils. Old tanked Linseed Oil is used in the preparation of what is known as boiled oil; that is, it is heated in a high temperature that it may more rapidly dry when used in varnish. This drying process is hastened by the addition of manganese dioxide, litharge, etc. Boiled Linseed Oil is much darker than raw oil, having a brown red shade. It is also much more viscous and has a higher specific gravity. Boiled oil is adulterated

in the same manner as is raw Linseed Oil, the adulterants being resin oils, resin, and mineral oils.

In rubber compounding Linseed Oil is very often used. A very simple formula for waterproofing canvas is India-rubber, litharge, sulphur, and Linseed Oil. It is also used in rubber varnishes, to a certain extent in molded goods, and quite largely in hard rubber compounding. It is used in the manufacture of rubber substitutes, and is well known as it is the basis of a great many of the vulcanized oil substitutes. Linseed Oil that is intended for mixing in linoleum is exposed to the air until it is thoroughly oxygenated. In this state it is insoluble in alcohol, chloroform, ether, and ordinary solvents.

LITHOGRAPHIC VARNISH is obtained by boiling linseed oil at a temperature higher than that at which boiled oil is prepared, nor are dryers added during the boiling. It is a perfectly clear, transparent substance, the best quality being nearly as light as raw linseed oil. There are two ordinary grades of Lithographic Varnish. One is known as "burnt oil," which is obtained by bringing raw linseed oil up to its flash point, and allowing it to burn until the required thickness is reached; it being constantly stirred meanwhile. "Oxygenated oil" is a linseed oil varnish made by treating the oil with oxygen in jacketed kettles, heated by steam. The product is as light colored as raw linseed oil, but heavier. It is also more readily soluble in alcohol, and has marked drying powers.

MANGANATED LINSEED OIL is used in certain rubber compounds where more of a drying effect is needed than is found in the raw linseed oil. It is linseed oil that has been boiled with peroxide of manganese to increase its drying qualities. (See Boiled Oil.)

MIRBANE OIL.—See Nitrobenzene.

MUSTARD OIL.—Black Mustard Oil is obtained from the seeds of the *Sinapis nigra*. It possesses a mild taste, is of a brownish yellow color, and in its chemical composition closely resembles rapeseed oil. It is a by-product and is largely used in soap making. White Mustard Oil is made from the seeds of the *Sinapis alba*. It is of a yellow color, and is almost identical with black Mustard Oil. Used in making rubber substitutes.

NEATSFOOT OIL.—A pale, yellow, colorless oil, obtained from the feet of oxen by boiling in water. It has a smooth pleasant taste. On standing it deposits stearine. It is largely adulterated with cheaper animal or vegetable and even mineral oils. Neats-foot Oil, mixed with Gutta-percha, tallow, sweet oil, and oil of thyme, is used as a rust preventive. It is used in connection with beeswax, India-rubber, and Burgundy pitch in a composition for dressing leathers or hides.

NITROBENZENE (also called Oil of Mirbane and "imitation oil of bitter almonds") is a yellow aromatic liquid produced by the action of nitric acid on benzene. It is used in perfumery and turned out in great quantities for the manufacture of anilines. It is used also in certain insulating compounds in connection with asbestos, powdered glass, vulcanized rubber, castor oil, resin oil, and celluloid in solution.

OIL OF LAVENDER has no perfume when new, but develops it on being exposed to the air. It is distilled from the flowers of the *Lavandula vera*, and is used sometimes to deodorize rubber goods.

OIL OF LEMON is obtained from fresh lemon peel. A very volatile yellow or colorless oil; specific gravity of 0.858; soluble in bisulphide of carbon, and absolute alcohol; often adulterated with fixed oils and alcohol; dissolves sulphur, phosphorus, resin, and fats; used to deodorize certain proofing compounds, cologne sometimes taking its place.

OIL OF ORRIS, or ORRIS OIL, is found commercially and is prepared from the root. It is lighter than water, and of the consistency of butter. Melts at 100° F., and is miscible with alcohol. Its odor is like that of violets. Is used in rubber as a deodorizer.

OIL OF PEPPERMINT.—A greenish yellow colorless oil, becoming reddish with age; of a strong and aromatic odor; and warm, camphor like, very pungent taste; specific gravity from 0.902 to 0.920; used in fine goods for its color.

OIL OF ROSEMARY.—An essential oil of the specific gravity 0.896. Colorless and having the odor of rosemary. Used with India-rubber, paraffine, and spermaceti in waterproofing compounds, and, where rubber is present, to neutralize its odor.

OIL OF TAR.—An oil distilled from tar. It is a mixture of

several lighter oils, and is made up of liquid hydrocarbons which hold in solution small quantities of anthracene, naphthalene, and paraffine. It is sometimes used for mixing with lubricating oils, and for coating bags that are to hold alkaline earths, the interior of the bag being washed with chloride of lime. The Earl of Dundonald recommended Oil of Tar as a coating for rubber, claiming that it had a preservative effect. It is also used in compounds for surface clothing.

OIL OF THYME (also called Origanum Oil) is extracted from the flowers and leaves of the *Thymus vulgaris*. It is yellowish red in color; its specific gravity is 0.92; and it has a pungent taste; it is used to disguise the odor of ale cements.

OIL OF WORMWOOD.—A pungent essential oil distilled from the *Artemisia absinthium*; employed at an early day to deodorize spirits of turpentine when used in rubber.

OLEARGUM.—A black viscid liquid of an oily nature used as a dull finish wash for rubber boots. Its composition is a trade secret.

OLEUM SUCCINI.—The same as Oil of Amber (which see); used in the manufacture of soap substitutes.

OLIVE OIL is expressed from the fruit of the olive tree, principally in the countries of Europe bordering on the Mediterranean. Its specific gravity is 0.916. It is adulterated frequently with cottonseed oil. Olive Oil is used in taking impressions from type faces in the matrix in which rubber type is cured. Mayall suggested the mixing of Olive Oil with clay until it formed a soft putty, and then incorporating it with India-rubber, the proportion being  $\frac{1}{4}$  pound of oil to 30 pounds of gum. The use of the oil enabled the goods to be more largely adulterated; he also used Olive Oil in connection with devulcanized rubber, not as a solvent, but because he claimed that it combined with the gum and improved its quality. Olive Oil is also used in hard rubber compounding. Rubber is sometimes heated up in Olive Oil mixed with zinc, soap, and borax for a proofing solution. It is also used in the manufacture of pegamoid.

PALM OIL is obtained from the fruit of various species of palm, principally from the west coast of Africa, and is known in commerce under as many names as there are ports of shipment.



It is expressed in a very rough fashion by the natives, who stir the palm kernels in holes in the ground until fermentation sets in and the oil rises to the surface. They also sometimes press the oil from the fresh fruits. The harder grades of Palm Oil are yielded by the former process, the latter giving the finer oils. Palm Oil varies in consistency. Its specific gravity is 0.945; its color yellow to reddish; its odor that of violets. It yields a soap readily with alkalis and dissolves in ether and in alcohol of 0.848 specific gravity. Palm Oil is very rarely adulterated, unless it is done by the native gatherers, who sometimes add sand as a make-weight. Commercially, where sand and water together exceed 2 per cent., an allowance is claimed from the seller.

White Palm Oil is that which has been bleached by heated chemicals or exposure to the air. "Lagos oil" has about the same consistency as butter, while "Congo oil" is as thick as tallow. Palm Oil is used largely in the manufacture of mechanical and dry-heat goods, chiefly to enable dry ingredients to mix more easily with India-rubber. It has also been used in the recovery of waste rubber by the mixing of the finely ground rubber with it and exposing the mass to a heat of 572° F. Palm Oil residuum is used in connection with resin oil as an insulator. Palm Oil is also used in the production of artificial elaterite.

PARAFFINE OIL is a petroleum product; it may also be prepared from coal tar and wood tar. It is a waxy substance of a white color, much resembling spermaceti. It is used chiefly as a lubricant, and is not acted upon by most of the chemical reagents. Paraffine Oil mixed with cottonseed oil is used in certain canvas proofings.

PETROLEUM OIL (also known as Rock Oil) is a dark, ill-smelling liquid, obtained from wells sunk in oil-bearing sands. Some Russian oils, however, are colorless. White Rangoon oil contains so much paraffine as to have the consistency of butter. The specific gravity of American petroleum varies from 0.8 to 0.85 or 0.9.

PETROLEUM PARAFFINE.—See Vaseline.

PETROLEUM JELLY.—See Vaseline.

PETROLATUM is a rubber compounding ingredient very generally used, especially in mechanical goods. It is one of the

numerous products of petroleum or rock oil derived by distillation. These products are classed as follows: Light oils, including gasoline and naphtha; illuminating oils, kerosene; residuum or tar. From the latter subdivision is separable, by further increase of heat, heavy lubricating and paraffine oils, among which are petrolatum or vaseline, and coke as a waste product.

Petrolatum gains much of its value from its indifference to volatile oils. It is separated from the residuum of crude petroleum which has been subjected to the vacuum process of distillation in contradistinction to the "cracking" process by which some of the natural constituents are chemically broken up to form new bodies. The residuum being kept fluid by steam, the finely divided coke resulting being the distillation is allowed to settle out and the clear oil drawn off and filtered through bone charcoal contained in cylinders, in order to remove the color and odors contained in it. Sometimes the oil recovered from the residuum is treated with sulphuric acid and potassium bichromate for the removal of certain impurities before the filtration through bone charcoal. This is said to be the German process.

Petrolatum gains much of its value from its indifference to all chemical treatment, thus resembling paraffine very closely. It is generally familiar as a dense product, pale yellow, translucent, slightly fluorescent, semi-solid melting at about 100° F., and having a specific gravity of 0.850. Its chemically inert quality peculiarly adapts Petrolatum to use in rubber compounding where a non-oxidizing lubricant and softener is needed to facilitate the manipulation of harsh or dry compounds, and which will not subsequently develop in the finished goods injurious or other inconvenient qualities. Simple softening of rubber any oil will accomplish, but for all around adaptability Petrolatum excels all others.

Ordinarily 2 or 2½ per cent. of Petrolatum is sufficient in any compound where its presence is needed, although 5 or even 7 per cent. may be employed in special cases. Cheap goods containing Petrolatum will withstand drying out or hardening with age, a similar effect being produced by the use of soft coal tar. As regards the item of economy, Petrolatum commends itself to the rubber manufacturer when considering the use of an oil ingre-

dient in compounding. For all ordinary purposes, everything except perhaps the whitest goods, the dark filtered stock is entirely suitable and the price will be less than the light filtered stock.

POPPYSEED OIL is obtained by pressing the seeds of the common poppy (*Papaver somniferum*). Commercially there are two grades, white and red. This oil has a pleasant taste and no odor; it is rarely adulterated with other oils, although occasionally sesame oil is found in it; it is an excellent drying oil, and its lower grades are used in the manufacture of soaps; its use in the rubber industry is chiefly in the manufacture of substitutes.

RAPESEED OIL (also known as Colza Oil) is a pale yellow in color, with an unpleasant harsh taste. Its specific gravity is about 0.916. It is largely adulterated with vegetable, mineral, or fish oils. It is obtained from the seeds of the *Brassica campestris*, and of several varieties of this genus which are cultivated. American oils from all of these are termed Colza or Rape Oil indiscriminately. In Europe, however, Rape is one kind of oil and Colza is another. There is also what is called the summer oil and the winter oil, a distinction which is of no interest to rubber manufacturers. Rape oil is hardly a semi-drying oil, nor is it yet a non-drying oil, but about half way between the two. It is used in the manufacture of certain rubber substitutes. Mixed with India-rubber it has been used as a somewhat costly mixture for lubricating machinery.

ROSIN OIL.—Made by subjecting resin to destructive distillation. The resultant oil is heavier than mineral oils, and its chemical composition is quite involved. It is largely made up, however, of hydrocarbons, with a certain amount of resin acids. Used in making a waterproof solution, by the addition of Japan wax and gum thus, in the manufacture of a solution for treating hides and leather. Used also in compounds for calking ships in which India-rubber has a part, and is an important ingredient in the manufacture of guttaline. (See Rosin.)

RUSSIAN MINERAL OIL.—Petroleum from the Baku oil wells.

SHALE OIL.—Chiefly produced in Scotland from a dark, coal-like looking material called shale. It is similar in nearly all respects to petroleum oil. Used with asphaltum in certain insulating compounds.

**SLUDGE.**—The brown or black residue obtained in the refining of petroleum after all the lighter oils have been distilled off. Known also as Petroleum Residuum. (See Sludge-oil Resin.)

**STEARINE.**—An important ingredient in animal and vegetable fats. It is quite solid, and increases the hardness, and raises the melting point of fat. Commercially, Stearine is also known as stearic acid. It is an important element in the manufacture of cravenettes, where it is used with ozocerite, beeswax, paraffine, and Japan wax.

**TALLOW.**—Beef tallow, when fresh, is almost white, free from disagreeable odor, and almost tasteless. On the other hand, foreign tallow runs from white to yellow and is often quite rancid. Tallow is often adulterated with resin oil, cocoanut oil, cottonseed oil, and paraffine wax. It is used in non-drying cements in connection with slaked lime and India-rubber. In connection with India-rubber it is also used in the production of what was known as Derry's waterproof harness oil, which was made of India-rubber, Tallow, seal oil, and ivory black. An etching varnish is made of Gutta-percha, turpentine, beeswax, and Tallow. A small amount of this was used by Hancock in compounding for softening Gutta-percha. It is used with Gutta-percha in shoemakers' wax, and also in certain proofing compounds with India-rubber, pitch, and linseed oil. Mixed with India-rubber, beeswax, and linseed oil, Tallow makes an excellent dressing for leather.

**TURPENTINE** was used in one of the earliest formulas in the manufacture of devulcanized rubber. (See Spirits of Turpentine.)

**VASELINE** is the purified residue from the distillation of petroleum. Its specific gravity is .875 to .945. It is insoluble in water, barely soluble in cold, but soluble in boiling absolute alcohol, and in ether, bisulphide of carbon, oil of turpentine, benzine, and benzol. It is the basis of a cheap waterproofing process, the other ingredients being silicate of soda, alum, and hot water. Vaseline is used quite often in general compounding for its softening effects. It is also combined with menthol and gum alibani in the manufacture of porous plasters. Vaseline has been used in the manufacture of substitutes similar to ruberite. (See Petrolatum.)

**VULCANIZED OIL.**—See Rubber Substitutes.



**WALNUT OIL.**—Cold drawn oil is very fluid, almost colorless, and of an agreeable nutty flavor. Hot pressed oil has a greenish tint and an acrid taste and smell. Is used in rubber substitutes, particularly in those in which peroxide of lead appears as a dryer.

**WHITE DRYING OIL.**—Bleached linseed oil.

## CHAPTER XII.

### SOLVENTS USED IN INDIA-RUBBER PROOFING AND CEMENTING AND IN COMMERCIAL CEMENTS.

THE beginnings of the manufacture of India-rubber consisted in putting the gum in solution and it was a considerable time before the discovery of the present processes of dry mixing, which are employed in the production of the greater part of the rubber goods now made. There are certain lines, however, where the use of solvents is still both necessary and economical. In the mackintosh manufacture, for instance, the rubber is in almost every instance spread in the form of solution, as a thinner coat can be spread in this way, offsetting the cost of the solvent. Many sheetings in various colors that, only a few years ago, were calendered, are now coated by the means of solution. In the making up of almost all lines of rubber goods, certain cements are necessary, and these are ordinarily made in the factory that produces the goods. The cements that are sold in bulk, such as channeling cements, for leather shoe manufacturing, as well as cements that are sold in smaller packages to repair men in the cycle industry, all consist of rubber and analogous gums treated with some suitable solvent. Before discussing the ordinary and the extraordinary solvents that interest the rubber manufacturer, it may be well to consider what the various solvents can do.

The following tables showing the solubility of India-rubber are of exceeding interest, therefore. The first, which is taken from the *Journal of the Society of Chemical Industry*, is a table of the solubility of masticated caoutchouc in solvents:

100 parts of:	Ceara Rubber	Para Negroheads	Sierra Leone Rubber
Ethyl ether .....	2.6	3.6	4.6
Turpentine .....	4.5	5.0	4.6
Chloroform .....	3.0	3.7	3.0
Petroleum benzene .....	4.4	5.0	{ 4.0
Carbon bisulphide .....	0.4	None.	{ 4.7 None.

Hoffer gives, as a result of his individual experiments, the following table of solutions, the samples in each case being 100 parts of well-dried India-rubber:

In bisulphide of carbon .....	65 to 70
In benzol .....	48 to 52
In oil of turpentine .....	50 to 52
In caoutchine .....	53 to 55
In ether .....	60 to 68
In camphene .....	53 to 58

The great differences in solubility between various grades of rubber have been found to be due, as much as anything, to the amounts of resins that are to be found in them. As these resins are soluble, and in some cases can be removed, it is important that rubber manufacturers not only appreciate their presence, but, where it is practicable, dissolve them out. These resins, according to Lascelles-Scott, who furnishes the following table, consist of abietic acid or some other similar body:

Description of Rubber.	Normal Resin (soluble in 85 p. c. Alcohol).	Description of Rubber.	Normal Resin (soluble in 85 p. c. Alcohol).
Para .....	.91	Ceara .....	1.16
Para .....	.60	Assam .....	6.45
Para .....	1.62	Assam .....	4.88
Para .....	1.14	Burma .....	5.20
Para .....	.85	Rio .....	3.37
Madagascar .....	4.06	Africa (various) .....	8.23
Madagascar .....	5.22	Africa (various) .....	10.60
Madagascar .....	2.84	Africa (various) .....	6.71
Colombia .....	3.40	Mangabeira .....	8.43
Colombia .....	2.11	Origin unknown .....	11.14
Ceara .....	2.33	Origin unknown .....	7.27
Ceara .....	1.80	Origin unknown .....	16.56

In some of them oxygen is a component part, and they are all soluble in alcohol of 85 per cent. strength and upwards. It will be noticed from this table that Para rubber has the least percentage of resin, and, of course, is the most valuable. The samples containing the largest proportions of resin were unmistakably adulterated with other gums during collection.

C. O. Weber gives the percentages of resin in a number of samples of rubber as follows:

Grade of Rubber.	Per Cent. Resin.	Grade of Rubber.	Per Cent. Resin.
Para (fine) .....	1.3	Sierra Leone .....	9.7
Ceara .....	2.1	Assam .....	11.3
Colombian .....	3.8	Mangabeira .....	13.1
Mozambique .....	3.2	African ball No. 1 .....	22.8
Rio Janeiro .....	5.2	African ball No. 2 .....	26.1
Madagascar .....	8.2	African flake .....	63.9

The patent of Frankenberg (English) covering the production of non-inflammable solutions of rubber is of exceeding

interest as suggesting the use of new and safe solvents. To-day few chlorhydrins are used, because of their expense, but a number of them are on the market and the cost is steadily being reduced. Frankenberg's solutions are produced by mixing rubber with carbon tetrachloride, dichlor-methane, trichlor-ethane, tetrachlor-ethane, or trichlor-benzol, alone or together. The rubber may be softened with coal-tar naphtha or other solvent before the above solvents are added.

ACETONE is a colorless mobile liquid, with a very unpleasant taste and peculiar odor, and outwardly resembling alcohol. It is a good solvent for many organic substances, and for many gums and resins. Acetone is produced by the destructive distillation of acetate of lime, which is one of the chemicals made from the products of wood distillation. It has a specific gravity of .80 and boiling point of 134° F. It is a solvent for rubber resins dissolving about 18 per cent. of Pontianak resin while hot and is recommended as a solvent for use in analysis of rubber, as it is without action on the gum.

ALCOHOL, when pure, is a colorless, thin, mobile liquid, of a somewhat disagreeable smell, burning taste, and specific gravity 0.792. What is known as absolute Alcohol is that which has been deprived of all water. Its specific gravity is 0.795. It eagerly absorbs water, and, as it becomes more dilute, its specific gravity rises; Alcohol of 60 per cent. has a specific gravity of .883. There are a number of forms of alcohol used in the arts. Alcohol, chemically considered, embraces a large class of similar bodies. Wood Alcohol or methyl Alcohol is made from the products of wood distillation, is a colorless mobile fluid with a specific gravity of .80 and a boiling point of 150° F. and is poisonous. It is a good solvent for many resins, but dissolves Pontianak resin scarcely at all. Some of the resins of other rubbers are attacked slightly by it. Grain Alcohol is the product of the fermentation of starch or sugar and in the United States is made largely from corn, rye, and molasses. It is chemically termed ethyl Alcohol and is the next in series above wood Alcohol. Its boiling point is 170° F. and its solvent powers for resins of rubber is greater than that of wood Alcohol, but some other resins are less soluble in the grain Alcohol. It can be brought to a purity of only 96



per cent. by ordinary distillation, and this grade is known as cologne spirits or neutral spirits. It does not dissolve rubber or sulphur, except the "beta" modification which crystallizes in yellow prisms. Dissolves readily in benzol but not in petroleum benzine except slightly. Dissolves fatty acids but not fats or fatty oils except castor oil. Soluble in most rubber solvents or dissolves them. Grain or ethyl Alcohol is the most commonly used Alcohol and is usually the one referred to unless others are specified.

Denatured Alcohol is merely grain Alcohol to which have been added small quantities of substances which render it poisonous and undrinkable. The most common formula for denaturing Alcohol is 5 per cent. wood Alcohol and  $\frac{1}{2}$  per cent. petroleum naphtha or gasoline. Many other special formulas are allowed. When so denatured it may be removed from the distillery without the payment of the government tax of \$1.10 per proof gallon or \$2.90 per gallon of 95 per cent.

Fusel oil consists of higher Alcohols and is obtained in the manufacture of grain Alcohol. It is insoluble in water and a solvent of many gums and of pyroxylin or celluloid. Other substances, for example, phenol and glycerine, are chemically alcohols, but are not so called in commerce.

None of these really are solvents of rubber, but are frequently and largely used in varnishes. India-rubber solution, when treated with large quantities of Alcohol, is deposited in a spongy form, the foreign ingredients in the gum going into the solution. Treated in this way it can be made an exceedingly white mass. It is also used in treating many of the pseudo guttas to dissolve out the brittle resinous matters. It has also been claimed that the washing of raw rubber with Alcohol dissolves resinous ingredients which are better absent, and that the rubber as a result lasts longer. Rectified spirit is what is generally known, or rather, used, in connection with India-rubber. It is used by the gatherers to coagulate the latex of the Balata, and is used also in the production of resinolines (which see). One of the early uses was to mix with it various solvents—for instance, with spirits of turpentine, coal oil, bisulphide of carbon, ether, chloroform, etc. When ill-smelling solvents were used, it was also often incorporated to neutralize the odor. In the Azo process for reclaiming

rubber, 20 parts of Alcohol to 1 part of bisulphide of carbon are used for softening and reclaiming rubber. Dental and other gums are exposed to the sunlight in Alcohol to increase the brilliancy of the colors and to make the shades lighter. Alcohol is also used to soften vulcanized rubber when a surface color is to be added. Alcohol, in connection with nitric acid, spirits of turpentine, and aniline, was used by Kelly for surface work on India-rubber.

ANTHRACINE.—A trade name for Naphthalene (which see).

BENZOL or BENZOLE is a volatile oil obtained in the distillation of coal tar, which must not be confused with petroleum benzene or petroleum naphtha. Its specific gravity is 0.899 at 32° F., and 0.878 at 68° F. Chemically it consists of 6 parts carbon and 6 parts of hydrogen and its combinations and products are the most numerous and best known of all chemical compounds. It is the basis of nitrobenzene and aniline which is the basis of the largest part of the coal tar compounds, colors and dyes. Commercially it is sold as pure, 90 per cent. and 70 per cent. By 90 per cent. Benzol it is meant that 90 per cent. will distill over at the temperature of boiling water and likewise with 70 per cent. The commercial Benzol is to a great extent obtained from the liquid which settles out from compressed Pitch gas. The commercial article is a mixture of Benzol with higher boiling bodies which are very similar in their chemical properties, and these bodies are mostly toloul or toulene which boils at 232° F. and xylol or xylene which boils at 287° F. and higher boiling homologues. It is slightly soluble in water, and freely soluble in alcohol and ether, and in bisulphide of carbon. It has great solvent properties. Benzol is used largely as a solvent for rubber in manufacturing bicycle cements, and also for dissolving rubber, and for the cold vulcanization of thin rubber fabrics containing chloride of sulphur, in which Benzol is much superior to carbon bisulphide; and at present it is much cheaper, both on account of less loss in handling, and also, of its much lower price per gallon. This refers more particularly to the high grades of Benzol, like 100 per cent. or C. P.; the 160° Benzol is mostly used where a solvent is required that must not evaporate too rapidly. It is said that if Gutta-percha is put in 20 times its weight of boiling Benzol, to which

one-tenth of plaster is added, and the mixture agitated from time to time, a perfectly clear solution is decanted. This is then mixed with twice its volume of 90 per cent. alcohol and the Gutta-percha precipitated a pure white. (See Naphtha.)

BISULPHIDE OF CARBON is a transparent liquid, the specific gravity of which is 1.27. It is exceedingly volatile, evaporating at ordinary temperature. When properly made its smell is somewhat similar to chloroform. The bad smell found in some is due to sulphureted hydrogen, and the presence of foreign matters from which it can be thoroughly freed by purification. It is highly inflammable, though not explosive, and has great affinity for sulphur, 100 parts dissolving 37 parts of sulphur, cold; and at 100° F. the same quantity will dissolve 94.5 parts. Bisulphide of Carbon mixes with every known substance capable of vulcanizing rubber. It also assimilates rapidly with all fatty oils, and dissolves all the resins, with the exception of shellac. It does not dissolve vulcanized rubber, however. Where it is used in rubber factories care is taken, as a rule, to remove the fumes, as they are injurious to the workmen. Some very serious cases of chronic poisoning have occurred through the use of this solvent, the symptoms being numbness, partial paralysis, and, in some cases, temporary insanity. The use of Bisulphide of Carbon in rubber factories is very carefully watched, therefore, by the authorities in Europe, proper means for ventilation and carrying off the fumes being insisted upon, and minors being excluded from rooms where it is used. It is one of the best and most common solvents for India-rubber, very largely used in the Parkes cold curing and similar processes, and in cements.

BISULPHIDE OF CARBON SUBSTITUTE, a liquid produced by Dr. Carl Otto Weber, is said to have been a perfect substitute for bisulphide of carbon. It had these advantages: less chloride of sulphur was needed, the smell of the vulcanized product was sweeter, the vulcanizing solution penetrated deeper into the rubber, the risk of burning the rubber and the uneven vulcanization were also done away with. It is also said that this substitute is not injurious to the health. It is manufactured in England.

BORAX is sometimes used as a solvent for rubber. (See Acids and Alkalies.)

CAMPHENE is a name applied to one of the varieties of spirits of turpentine which was once largely used as a burning fluid. It is very volatile, and the vapor may exist in the air in explosive quantities. Camphene was formerly used to a certain extent as a solvent for India-rubber. Under Newton's method of recovering rubber, the waste was placed in a closed vessel, covered with Camphene, and heated to 158° F. for fourteen days. The solvent was then distilled off, and the tough mass remaining was capable of utilization, and was somewhat similar to unvulcanized rubber. It was also used in the boot heel cements in the old-fashioned method of attaching them to rubber boots, and also in general shoe cements. Camphene was also used in putting vulcanized waste, finely powdered, into a solution in connection with ether and alcohol, in a simple but somewhat expensive process of recovery.

CAMPHOR has been used as a solvent for utilizing the waste of vulcanized rubber and of hard rubber, the waste being first treated with any ordinary solvent and then placed in a still with a certain amount of Camphor, when the India-rubber is dissolved and the solvent passed out and distilled over again. Granulated Camphor, over which had been passed sulphurous acid gas until it was reduced to a liquid, was used also as a solvent for India-rubber, by Alexander Parkes. (See Gums, etc.)

CAOUTCHOUCINE, also spelled Caoutchine, is a crude oil of India-rubber, made by its dry distillation, and smelling much like naphtha. It is an excellent solvent for India-rubber, but of course is too expensive for ordinary use. India-rubber immersed in it swells exceedingly, and a considerable quantity of it is dissolved during the boiling. It must be kept in hermetically sealed vessels, as it has a great affinity for oxygen, which it absorbs energetically. In preparing it, the India-rubber is treated in a retort at a heat exceeding 400° F. Caoutchoucine dissolves in ether or alcohol, and, absorbing oxygen freely, forms a resinous body as a result.

CARBON TETRACHLORIDE is a heavy, colorless, transparent mobile liquid, having a neutral reaction. Its odor is agreeable, but poisonous, resembling that of chloroform. It is non-inflammable and non-explosive. The vapors do not support combustion,



but act in the reverse as a fire extinguisher. The specific gravity of Carbon Tetrachloride is 1.6; the boiling point  $77^{\circ}$  C. or  $170^{\circ}$  F. The liquid is insoluble in water, diluted alcohol containing less than 75 per cent. by volume of absolute alcohol and also in glycerine and the glycerides. It is freely soluble in acetone, glacial acetic acid, oleic acid, liquid carbonic acid and aqueous solution of carbolic acid, ethyl, and amyl alcohol, chloroform, carbon disulphide, benzol (Petroleum benzine), ether and aniline, oil of turpentine, petroleum and all petroleum products, also in fixed and volatile oils and oleoresins.

It dissolves oils, fats, resins, wax, India-rubber, Gutta-percha, ceresin, spermaceti, paraffine, stearin, varnish, paints, asphaltum, pitch, balsams, coal tar, pine tar, and soda and potash soaps. It also dissolves salicylic acid, carbolic acid, iodine, bromine, iodoform, bromoform, menthol, thymol, camphor, camphor monobromate, naphthalin, etc. It furthermore dissolves several gases, among others ammonia and hydrogen sulphides. It is not acted upon by the strong mineral acids and is not decomposed by an aqueous solution of potassa, which will, however, remove any carbon disulphide or hydrogen sulphide present.

It is strongly recommended as an extracting medium. It is important to remember that in contrast with benzine, gasoline, etc., Carbon Tetrachloride ( $\text{C Cl}_4$ ) is a single chemical compound, and in its recovery from the extracted fats, grease, etc., it is always obtained as the same chemical combination, with the selfsame properties; whereas in benzine or gasoline there are unavoidable losses to be sustained, particularly the valuable, very volatile parts, so that with a continued use of benzine the remaining less valuable ingredients, the heavier oils, must finally be enriched by important additions of fresh benzine or gasoline.

An apparatus already installed for the recovery of the solvents does not need to be remodeled for the recovery of Carbon Tetrachloride, and distillation process may be likewise carried through in the customary manner. Carbon Tetrachloride does not in the least affect the colors of fabrics. The most delicate colors, even aniline colors of silk, satin, laces,

etc., are not affected in the slightest degree. A mixture consisting of equal parts of turpentine and Carbon Tetrachloride cannot be ignited at ordinary temperatures. A mixture of 60 per cent. Carbon Tetrachloride and 40 per cent. naphtha is likewise non-inflammable at ordinary temperatures.

**CHLORIDE OF CARBON.**—This is obtained by the distilling of bisulphide of carbon into a vessel containing pentachloride of antimony, the product being rectified by distilling with lime. According to Simpson, this makes a good solvent for India-rubber and in a measure vulcanizes it. Newton also used a Chloride of Carbon in dissolving both India-rubber and Gutta-percha, while Crump used Tetrachloride of Carbon (which see).

**CHLOROFORM** is prepared generally by distilling together a mixture of spirit—that is, grain alcohol—with bleaching powder and water. Its density is from 1.496 to 1.498. It is one of the best rubber solvents known. It is costly, however, and has a bad effect upon workmen. Lascelles-Scott mentions what he calls the A. C. E. mixture, composed of alcohol 15 parts, Chloroform 38 parts, and ether 47 parts, which yields a powerful solvent for India-rubber or Gutta-percha. Chloroform dissolves not only India-rubber, but fats, resins, sulphur, alkaloids, and many other organic compounds. It should be remembered that a small percentage of Chloroform in the air, even as little as 5 per cent., is dangerous to the workmen. Chloroform is used as the solvent for India-rubber which is treated with the ammoniac gas process for bleaching. Is also used alone, and in connection with naphtha for rubber cements, which are intended to adhere to glass. In the bleaching of Gutta-percha, it is also used as a solvent. One of the first uses of Chloroform in connection with India-rubber is to be noted under an American patent granted to Charles F. Durant, who announced the discovery of a solvent known as "perchloride of formyle, otherwise known as Chloroform."

**CREOSOTE OILS**, in connection with ordinary solvents for India-rubber, are said to produce a cheap and effective solvent. Indeed, John Bagnol, manufacturer for Charles Macintosh & Co., patented their use as applied to India-rubber. (See Creosote.)

CHUTE'S RUBBER RESIN SOLVENT.—This is a mixture of methyl acetate with either acetone or methyl acetone. Patented in the United States in 1907.

DICHLOR-ETHYLENE is a non-inflammable, non-poisonous solvent, of German origin. It has a density of 1.269, with a boiling point of 83° C. or 181° F.

DIPPEL'S OIL (or Bone Naphtha).—A thick, viscid oil of brown color and very disagreeable odor, which on distillation may be obtained limpid and colorless. It is prepared by the destructible distillation of bones, leaving boneblack as a residuum. It was one of the early solvents used for India-rubber.

ETHER.—This was one of the early solvents used in connection with India-rubber. It is sometimes called Sulphuric Ether, but erroneously. It is prepared usually by distilling a mixture of alcohol and sulphuric acid, washing the distillate, and rectifying the product with quick lime or something of that kind. It is a colorless, very mobile liquid, with a not unpleasant smell, burning taste, and very volatile. Its specific gravity is 0.7183. It is soluble in water 1 to 12. Commercial Ether boils at 96° F., and yields a dense vapor. It is very inflammable, and, when mixed with air or oxygen, gives rise to a dangerous explosive mixture. It is one of the best solvents known for oils and fats, and is also an excellent solvent for sulphur. For use in rubber work Ether should be free from water, but not absolutely pure, necessarily. It is little used to-day in rubber mills, except in some lines of very fine work. It has the advantage of being absolutely free from the smells that many solvents have. A little is sometimes added to ordinary rubber solutions to make a complete solution of India-rubber in naphtha. There are also certain processes, expensive ones to be sure, for treating perished rubber with Ether vapor to recover it. Ether was used to remove sulphur from vulcanized India-rubber waste in Newton's camphene process.

GASOLINE.—See Naphtha.

HEPTANE.—One of the four isomeric hydrocarbons of the paraffine series, which occurs as a colorless liquid and is derived from heavy canned coal oil, petroleum, etc. Its specific gravity is 0.712. It is soluble in alcohol and in ether, and is

used with paraffine wax and India-rubber in water-repellent compounds.

**ISOPRENE.**—A body found in oil of caoutchouc. It boils at 98.6° F., and possesses the property of absorbing quantities of oxygen when exposed to the air, in consequence of which it forms itself into an elastic spongy mass. This same volatile compound is obtained by the action of moderate heat on oil of turpentine. William A. Tilden, D.Sc., F.R.S., had some Isoprene from turpentine placed in a bottle, his first result being a limpid, colorless liquid. After a time, this changed in appearance, looking like a dense syrup, on which floated several hard elastic masses. On examination, they turned out to be practically India-rubber. This rubber united with sulphur in the same way as ordinary rubber, forming a tough, elastic compound. It was also soluble in benzine, etc. Dr. Weber, before the Society of Chemical Industry, reported on Tilden's discovery that Isoprene is so expensive that it cannot be converted into rubber without loss, and therefore the synthetical manufacture of India-rubber, even if possible, was not probable.

**LIGROIN.**—See Naphtha.

**METHANE.**—Professor Lascelles-Scott describes the manufacture of what he calls Methane solvents, which are really benzines or benzols through which marsh gas has been passed. He claims that a benzine containing from 2 to 3 per cent. of Methane, obtained in this way, yields a better and more mobile solution than the ordinary solvent naphtha, and the solution when spread dries off better, besides giving a more finished surface.

**NAPHTHAS.**—The term Naphtha was originally applied to a variety of pungent, volatile, inflammable liquids that belonged chiefly to a class of ethers; then it took in oils of natural origin, such as rock oil, petroleum oil, etc.; at a later date, a light oil of coal tar, which should properly be designated benzol, was included under the name of Naphtha; while recently it has been extended so that it covers most of the inflammable liquids distilled dry from organic substances. It is applied in the United States to a series of hydrocarbons that are obtained from petroleum, whose boiling points vary with the densities,



from 65 to 300° F. The Naphthas of commerce are Bog-Head Naphtha, obtained from bog-head coal; Bone Naphtha, or Dippel's animal oil; Coal Naphtha, obtained from the distillation of coal tar; Wood Naphtha, or methyl alcohol obtained during the dry distillation of wood. Of these, Coal-tar Naphtha and Petroleum Naphtha are most useful to rubber manufacturers. The former of these was used largely as a rubber solvent, but to-day it is almost wholly replaced by Petroleum Naphtha. The Naphtha which is derived from petroleum comes between gasoline, which is lighter, and benzine, which is heavier. Benzene is contained in the Naphtha produced by the destructive distillation of coal, while benzine is a petroleum product. Benzine is really the first product that arises from the process of refining crude oil, and bears the same relation to Naphtha that the distillate does to refined oil, thus showing that benzine is simply a crude Naphtha. What is known as gasoline has a proof rate of 86° F., and boils at 90° to 100° F. Warm currents of air volatilize this type of Naphtha very rapidly, and its vapor unites with the atmosphere in explosive proportions.

Coal-tar Naphtha was one of the first solvents used in rubber work. Macintosh, as far back as 1823, prepared it himself for dissolving India-rubber for proofing. There is obtained from crude Coal-tar Naphtha what is known as "once run" Naphtha and "last runnings." The once run Naphtha is the starting point from which are derived the various grades of benzols, solvent Naphthas, etc., by fractional distillation. The specific gravity of solvent Naphtha should not exceed 0.875. Its composition is a very complex affair, including xylols, cumols, homologous of benzol, together with some paraffine, and sometimes a little naphthaline. This last-named substance, by the way, is often objectionable, as it acts upon some rubbers like animal oil. Naphtha derives its vegetable solvent power largely from the xylol present in it. This is to-day removed and sold by itself as a solvent, though the residual Naphtha is simply robbed of that much virtue.

Speaking of Naphthas, Lascelles-Scott, after exhaustive experiments, thus describes three used in England in rubber factories. Petroleum Naphtha in its solvent action on rubber

showed slight action in the cold or under gentle heat. Viscid masses and semi-solutions were formed, but these solutions did not dry well. The same Naphtha had almost no solvent action on pitch. Shale Naphtha was useful only in dissolving Madagascar rubbers, and had no action on pitch, while Coal-tar Naphtha caused almost any rubber to swell quickly and, after gentle heat, to effect a good solution. It also readily dissolved pitch, forming a deep brown solution.

The problem that confronts rubber manufacturers as a rule is the solution of gums that are more or less heavily compounded, which is an easier problem than the putting into solution of crude rubber that perhaps has not been broken down in any way. At the same time it is customary in many cases to apply a little heat during the mixing. The following table relates to Petroleum Naphthas. The *C* Naphtha has not only the greatest solvent power, but it is easier to evaporate after it has dissolved the rubber compound. *B* and *A* require a certain amount of heat to vaporize them:

Products.	Specific Gravity.	Degrees Beaume.	Boiling Points.
Rhigolene .....	0.625	..	65° F.
Gasolene .....	0.665	85	120° F.
<i>C.</i> Naphtha .....	0.706	70	180° F.
<i>B.</i> Naphtha .....	0.724	67	220° F.
<i>A.</i> Naphtha .....	0.742	65	300° F.

Naphtha is more largely used in the proofing business than any other. It is, however, a general solvent for cements, and quantities of it are used in almost all lines of rubber work where there is any making up to be done of separate pieces after calendering. It is therefore necessary that a good grade be used when one considers the danger that may come from fires caused by the explosion or easy ignition of low grade solvents. Odorless Naphthas are those from which naphthaline, a solid white body, has been removed, as it is the presence of this body that causes the strong smell. Naphtha treated by sulphuric acid is deodorized, acquiring a rather pleasant odor as a consequence. It is often mixed with other solvents—for example, with oil of turpentine—and is found thus to have a better effect on the rubber.

NAPHTHALINE (called also Anthracine).—Commercially

obtained from coal-tar, being among the third and fourth products of the distillation of that body. Naphthaline is usually sold in rolls made by melting the large silvery plates or scales in which it crystallizes, and running the melted compound into molds. Its specific gravity is 1.15. It is insoluble in water and petroleum naphtha, but the liquids derived from coal tar dissolve it easily. Naphthaline is sparingly soluble in alcohol and ether, but readily in benzol. It is used in insulating paints, as when it evaporates it leaves a very solid film that is said to be absolutely free from porosity.

NITRO BENZOL.—A compound obtained by boiling benzol with nitric acid. It is a brown, heavy, oily looking liquid, having a specific gravity of 1.2, a burning sweet taste, and a smell resembling that of oil of bitter almonds. It is used in the analysis of vulcanized India-rubber to dissolve the substitute that may be incorporated in it. It is produced by the action of nitric acid and benzene, also called Nitro-Benzene. Used by Parkes in the manufacture of Parkesine. (See Acids and Alkalies; also Naphtha.)

OIL OF TURPENTINE (crude) is what is known as an oleo resin, and is of about the consistency of fresh honey. There are more than a dozen varieties on the market, the more common being Bordeaux, Venice, Canadian, and American. A fair quality of turpentine oil should begin to boil at 155° C. or 312° F. The distillation of crude Oil of Turpentine by steam leaves ordinary resin. Oil of Turpentine is used in certain water-proof cements, in connection with both Gutta-percha and India-rubber. Where Oil of Turpentine is necessary for rubber work, it is well to have it free from the considerable percentage of water which it invariably contains. This is done by a treatment with sulphuric acid, or by rectifying it over burnt lime. Turpentine, particularly that known as Venice Turpentine, is often used in connection with linseed oil and sulphur in the production of rubber substitutes. Professor Tilden showed, some years ago, that what appeared to be pure India-rubber could be obtained from turpentine; indeed, he announced that he had produced it on a small scale. The same thing was also observed by Bouchardt. Venice Turpentine is obtained from

Switzerland, where it is procured from the *Larix Europea*, or larch. The genuine Venice Turpentine is of the consistency of honey, cloudy, yellowish, or slightly greenish. It is entirely soluble in alcohol. The commercial Venice Turpentine is a factious substance, usually quite brown, and is prepared by dissolving rosin in Oil of Turpentine. Venice Turpentine is largely used in cements. Bordeaux Turpentine is the ordinary turpentine of commerce, getting its name from the port in France whence it is exported. (See Spirits of Turpentine.)

PENTANE.—A hydrocarbon of the paraffine or methane series. A colorless, volatile liquid which occurs in petroleum. Boiling point 98° F. Pentane is used with paraffine wax and India-rubber in water-repellent compounds.

PETROLEUM.—A mixture of several hydrocarbons which, in fluid form, issue from the ground in many parts of the world; also known as rock oil. It varies in consistency from a thin, light, colorless fluid with a specific gravity of about 0.750, to a substance as thick as butter, and almost as heavy as water. All kinds, however, have about the same constitution, consisting of carbon and hydrogen compounds only, and containing no oxygen. Asphalt and bitumen are closely allied to petroleum. This oil is often used for restoring rubber that is oxidized somewhat, by immersion, and then hanging for a couple of days in a warm atmosphere. Petroleum is very rarely used in rubber manufacture, for although a good solvent, it weakens the goods exceedingly. Crude petroleum, however, is a valuable adjunct to the reclaiming of rubber, where, in the form of a cheap residuum, it assists in devulcanization and in sheeting. (See Naphtha.)

RESIN OIL.—This is obtained by subjecting rosin to dry distillation, the specific gravity of the resultant oil ranging from 0.96 to 0.99. It is rarely used as a solvent for rubber, in the ordinary meaning of the term. As a matter of fact, it is not a good solvent for crude rubber. For compounded rubbers, however, it works well and is often used, particularly in connection with pseudo guttas. In certain insulating experiments, where a thin sheet of Gutta-percha covered the conductor, and the outer Gutta-percha tube was full of Resin Oil,



it gave, according to Professor D. E. Hughes, F.R.S., a higher insulation test than Gutta-percha alone. Professor Hughes used Resin Oil quite thick and viscid, and added resin and a solid residuum obtained from the distillation of palm oil. Resin oil in rubber compounding, however, softens the compound in a marked degree. (See Oils).

RHIGOLENE.—See Naphtha.

SHALE SPIRIT is the solvent used in the Scottish waterproofing establishments. It is a product of the Scottish paraffine oil industry.

SPIRITS OF TURPENTINE is really oil of turpentine, and it has a specific gravity of 0.864. It is colorless, transparent, of a strong odor, and a bitter taste. It is insoluble in water, on which it floats, but readily soluble in strong grain alcohol, ether, and the fixed and essential oils. It is an excellent solvent for sulphur, resin, and India-rubber. Spirits of Turpentine, with wood spirit alcohol, aniline, and nitric acid is used in surface work on vulcanized India-rubber. The earliest records of India-rubber speak of this oil as a solvent for it; indeed, the whole secret of rubber compounding for a number of years, even when the great Roxbury Rubber Co., of Boston, was running, was the solution of India-rubber in it. It is used in solutions that are expected to be sticky, and to dry slowly.

TETRACHLORIDE OF CARBON.—See Carbon Tetrachloride.

TETRACHLORMETHENE BENZINE SUBSTITUTE is an excellent solvent, boiling at 75° C. Not easily ignited; of pleasant smell; made from chlorine and carbon bisulphide.

THION.—A substitute for bisulphide of carbon, manufactured in England, which is said to mix excellently with chloride of sulphur and is non-poisonous.

TOLUENE.—That oil which is distilled from coal tar at a temperature of 230° to 234° F., also called methyl benzine and Toluol. It resembles benzene in outward appearance. Much commercial benzol contains Toluene, and this it is that makes it a far better solvent for rubber than benzine itself, as it dissolves the rubber in five-sixths of the time. The solutions are more mobile; it has a higher boiling point; and, given a quantity of the solvent, will reduce more gum. It does not chill in cold weather, but keeps

on macerating. It leaves a more solid deposit than does benzine, and does not induce headache or sickness among the workmen.

VULCOLEINE is a liquid of English origin, and is put upon the market at about the same price as carbon bisulphide, and used for a solvent for India-rubber. It leaves on evaporation a perfectly tough and elastic film, quite unlike that left by coal tar naphtha, or the usual solvents. It mixes instantly with chloride of sulphur, and is intended to replace bisulphide of carbon in the cold curing process. It has no bad smell, nor is it unhealthful.

WOOD SPIRIT (also known as Pyroxylic Acid).—This is made from the destructive distillation of wood. Wood Spirit resembles grain or ethyl alcohol in its affinities, forming a series of compounds exactly corresponding to that of spirits of wine. Wood Spirit, when pure, is a thin, colorless liquid, with a peculiar odor and a hot disagreeable taste. It boils at 152° F., and its density is .798 at 60°. It mixes freely with water, and, like alcohol, dissolves resins and volatile oils, and is used as a cheap substitute for that purpose. Wood Spirit, also known as methylic alcohol, is not methylated spirit. It is not a solvent of rubber, but is used in many compounds that are intended as substitutes for vulcanized rubber. It is also used in dyeing India-rubber in connection with nitric acid, alcohol, and aniline.

XYLOL.—A colorless, somewhat aromatic, inflammable, oily liquid found in coal tar and wood tar; also called Xylene. (See Benzol.)

## CHAPTER XIII.

### MISCELLANEOUS PROCESSES AND COMPOUNDS FOR USE IN THE RUBBER FACTORY.

MANY interesting formulas are given for the dyeing and surface coloring of rubber, although the processes are not such as will generally be used. A suggestion that comes from France is the dipping of rubber for an instant in a bath of nitric acid, then washing in water. For coloring, the rubber is dipped in an alcoholic solution of fuchsine. The experimenter should appreciate fully, however, the effect that nitric acid produces on rubber, and govern himself accordingly.

Alexander Parkes, who produced some exceedingly valuable processes for the treatment of rubber, gives the following formulas for dyeing India-rubber:

Black.—Boil from 15 to 30 minutes in a liquid prepared as follows: Sulphate copper, 1 pound; water, 1 gallon; caustic ammonia or muriate of ammonia, 1 pound. Or: Sulphate or bisulphate potash, 1 pound; sulphate copper, 12 pounds; water, 1 gallon.

Green.—Muriate ammonia, 2 pounds; sulphate copper, 1 pound; caustic lime, 4 pounds; water, 1 gallon. Boil the rubber as before, 15 to 30 minutes.

Purple.—Sulphate or bisulphate of potash, 1 pound; sulphate of copper,  $\frac{1}{4}$  pound; sulphate of indigo,  $\frac{1}{4}$  pound. Boil the rubber, 15 to 30 minutes.

Hoffer gives almost the same ingredients for producing these colors, adding the information that the articles are dyed by being boiled in these fluids from 15 to 30 minutes, the thicker the article the longer the boiling. This is done before the goods are vulcanized.

Hard rubber may be decorated by means of pigments mixed with shellac and applied to the given surface with a brush. The surface then is to be pressed with some force against a hot plate of metal, whereby the colors are made to appear as though integral with the rubber.

Wood coated a sheet of vulcanized rubber with chloride

of silver, the idea being to use it in dental plates. Various processes have also been brought out for the surface treatment of rubber with gold leaf, bronzes, etc., usually applied in the form of powders, in the manner in which flock is applied. Truman also patented a process for electro-gilding rubber dental plates after they were finished. Goodyear dusted unvulcanized rubber surfaces with plumbago or powdered metal, to make them conductive, pressed the dust in, and then electroplated it.

The embossing of India-rubber surfaces has been practiced almost since the invention of the "triple compound." It is really nothing more than a light surface molding. This is done sometimes by embossing rolls, the rubber being cured after the impression is taken, and sometimes by being vulcanized on the impression plate.

Bourbridge patented a process for embossing rubber by rolling it tightly on a drum with embossed paper or bookbinders' cloth, and semi-curing it in that form, preferably by boiling at a temperature from 212° to 220° F. This boiling operation was not really vulcanization, but simply a means of setting the rubber which was afterward made up into goods and cured.

In producing sheets of India-rubber for the manufacture of tobacco pouches, balls, balloons, etc., by this process, the sheet is calendered on sized cloth, partially vulcanized, printed, coated with transparent India-rubber, the goods made up, and the vulcanizing process completed.

A great many beautiful colors are added to India-rubber surfaces by coating the sheet with a thin adhesive solution, dusting it over with colored flock, and then vulcanizing. By this process any color can be given to rubber surfaces which have a cloth-like appearance.

Kelley produced a bronzed appearance on rubber coated fabrics by means of a roller partly immersed in a trough holding the dye, curing either by dry heat, or by chloride of sulphur. His solution consisted of 2 ounces alcohol spirits, 1 ounce wood naphtha, 10 drops nitric acid, 1 ounce spirits of turpentine, with sufficient aniline dye to make the desired



color, 4 ounces liquid dyeing, 3 pounds rubber composition. He also impregnated farina with aniline solutions, dried it, and mixed it in the compound.

In certain dyeing processes lakes are necessary. What is known as caoutchouc lake is made by steeping 1 ounce of Para rubber in a quart of light camphor oil, exposed to the sunlight for several days. This is said to be excellent for binding colors.

Matthew's process for producing colored designs for proofed fabrics is to first coat the fabric in the ordinary manner with pure or colored India-rubber. When the design is to be printed on a black or dark ground, the last coating is mixed with starch or some powder that will render it non-adhesive, and to an extent absorptive. The fabric is then partially vulcanized, when the designs are printed on the desired surface, just as oil-cloth or linoleum is printed. The vulcanization is finished preferably by using chloride of sulphur.

Colors suitable for admixture with rubber should answer the following requirements: They must be unaffected by water, by acids, by alkalis, and by chloride of sulphur. Further than this, they must not be affected by sulphur at temperatures ranging from 200° to 300° F. The colors must not be soluble in or affected by naphtha or other solvents used in rubber work. They must not be affected by heat up to 300° F. According to Frankenburg, his invention of aniline lakes answers all these requirements. His description is as follows:

(A). Lakes prepared from acid aniline colors.—“I have found that by converting any of the acids or suphonated aniline colors into compound lakes, such as barium-alumina, calcium-alumina, barium-chromium, or calcium-chromium lakes, colors are obtained answering all the above requirements, and therefore eminently suitable for the dyeing of India-rubber, waterproof, and other articles. The aniline dyes best suited for the production of these lakes are those known as azo or di-azo colors. From colors of this description I prepare lakes in the following manner: 50 pounds of orange II., or any other suitable azo or di-azo color, and 112 pounds of soda crystals

are dissolved in 100 gallons of water at 170° F. This solution is then precipitated with a solution of 150 pounds of barium chloride. The precipitate is kept boiling for half an hour. It is then left to stand, and washed several times with fresh water. Eventually a solution of 40 pounds of alumina sulphate is added very gradually, when a bright, fast, and flocculent lake is obtained, which, after filtration, drying, and pulverizing, is ready for incorporation with the India-rubber dough. It is evident that a great many variations of the process may be devised, but in every case the important point is the conversion of the aniline dye into one of the above-mentioned compound lakes. As regards the proportions given above, they are, of course, subject to such variations as are in accordance with the molecular weights and the commercial purity of the materials used, as well as with the particular properties and qualities to be imparted to the lakes for the purpose they are intended to serve. Using in this manner the numerous azo and di-azo dyes a very great variety of lakes may be produced, comprising all conceivable shades, and all suitable for the dyeing of India-rubber articles of every description. The lakes prepared from the acid oxy-ketone dyes and most of the natural dyes are very little suitable for this purpose, owing to their indifferent and dull shades."

(B). Lakes prepared from basic coloring matters.—"A large number of lakes derived from this class of dyes are also suited for the dyeing of India-rubber articles, although many of them are lacking in fastness to light acids and alkalies. To produce a perfect compound lake from these dyes tannic-acid and antimony, along with aluminum and barium, are used for the complete fixation and precipitation of these lakes. The following proportions give good results: Soda carbonate, 128 pounds; barium chloride, 110 pounds; thioflavine, 25 pounds; tannic acid, 20 pounds; acetate of soda, 20 pounds; sulphate of alumina, 100 pounds. These colors can be made faster by adding to them a small quantity of antimony potassio-tartrate. The proportions of tannic acid, sodium acetate, and tartar emetic used in this process vary considerably with the different basic colors, such variations being due to the difference in

the atomic weights and commercial purity of the basic dyes."

Hebblewaite and Holt's process for producing designs on gossamer cloth calls for the spreading over the rubber surface of farina or other powder, then running the fabric through embossed rollers and producing patterns thereon.

Mosley's ornamented fabric was a gossamer cloth covered with farina, the surface being printed much as calico is, and then vulcanized with chloride of sulphur. The colors were mixed with suitable solvents and a certain amount of paraffine or India-rubber added. A part of this invention was also the use of an engraved roller, which revolved in the vulcanizing solution, and came in contact with the surface of the rubber, only at its raised portion. Directly after passing over the roller, if the surface of the rubber were dusted with farina, it would adhere to the portions that had come in contact with the roller, and not to the rest, thus producing a design on the fabric. The whole of the coating was afterwards cured by vapor.

IMPREGNATING RUBBER.—Lessnenn and Weinkopf advise the following: Sixty per cent. birch tar oil; 38 per cent. coal tar benzine; 2 per cent. dissolved dextrine, to prevent sun-cracking. Apply with brush.

#### SHOWER-PROOF PROCESSES.

THE Cravenette and other processes for rendering textile fabrics waterproof or water-repellent have attracted so much attention in the rubber trade that space will be given here to a description of the Wiley patent, which is used at the Cravenette Works, Bradford, England. To begin, the waterproofing compound is applied in a solid or hard state by the action of friction and heating. In other words, there are no solvents used, nor is it a calendering process. The advantage of this is a lessening in the cost of applying waterproofing solutions and a further valuable result is that the dyes on various fabrics are in no way disturbed, and no unpleasant odor is developed or imparted to the cloth. The substances chosen are those which have a low melting point, so that the fabrics are not damaged by heat. They are preferably ozocerite, stearine,

spermaceti, paraffine wax, beeswax, or Japanese wax. These are sometimes used singly, and sometimes in combination, considerable judgment being necessary in selecting those which have an affinity for or are readily absorbed by the fibers of particular fabrics, influenced also by the nature and color of the fabric. In some cases India-rubber, Gutta-percha, maltha, asphaltum, resin, and artificial gums are found valuable in small proportions, and in conjunction with the substances already mentioned.

In order to apply the waterproofing substance, it is formed into slabs. The fabric is carried on a reel supported in bearings between suitable frames, at the opposite end of which is a hollow cylinder mounted upon carrying rollers and supported laterally by side rollers. This cylinder is filled with water. The slab of the compound, wider than the fabric to be coated, is fixed in a holder above the cylinder. This holder is so arranged that the weight presses the slab against the cylinder. The fabric is then drawn from the reel over and under tension bars, under a supporting roller, between it and the rubber cylinder, and around the cylinder and under the slab, then over the guide roller and into a drying machine. The friction of the cloth wears the slab away and uniformly deposits it upon the cloth, while in the drying machine, the heat melts the waterproofing compound, and it is absorbed by the fibers which are thereby rendered waterproof or water-repellent.

Other formulas for shower-proofing and waterproofing are of interest in this connection and a few are given :

The first is a German waterproofing compound: Alum, 10 pounds; sugar of lead, 10 pounds. Dissolve in hot water and allow the precipitate to settle. Dilute the clear liquid with 120 gallons water and add 2 pounds isinglass in solution. The goods are steeped in this solution 8 or 10 hours.

An American shower-proof compound: Liquid silicate of soda or liquor of flint, 1 gallon; white oxide of zinc, 1 pound. if the fabric is to be colored, add coloring matters. The mixture may be applied to fabrics hot or cold, by means of a brush or by immersion of the fabrics, which are afterwards to be run between rollers.



Another American compound: Dissolve separately,  $1\frac{1}{4}$  pounds alum (in hot water), 10 ounces acetate of lead (in hot water), and  $1\frac{1}{2}$  pounds carbonate of magnesia (in hot water). They should aggregate about 31 quarts. Add the acetate of lead to the alum solution, and then the carbonate of magnesia; after which 10 quarts liquid as above and 1 tablespoon white gum arabic. Stir  $\frac{1}{2}$  hour; let stand 24 hours, skimming now and then; in 48 hours the first mixture will be ready. Lay the fabric in a vessel and pour liquid over it, beating the fabric well and removing it within an hour.

A third American shower-proof compound:

- |                            |           |
|----------------------------|-----------|
| A. Carbonate of soda ..... | 16 parts. |
| Lime .....                 | 8 parts.  |
| Water .....                | 32 parts. |

Boil 30 minutes, let settle and pour off the clear lye.

- |                           |          |
|---------------------------|----------|
| B. Glue or gelatine ..... | 3 parts. |
| Linseed oil .....         | 3 parts. |

Add after soaking glue in cold water 12 hours.

- |                                       |           |
|---------------------------------------|-----------|
| C. Tallow (or other animal fat) ..... | 16 parts. |
| Rosin .....                           | 8 parts.  |

Melt together.

To (A) boiling hot add hot (C), then pour in (B) and stir hot until well mixed.

- |                              |                      |
|------------------------------|----------------------|
| D. Sulphate of alumina ..... | 1 pound.             |
| Acetate of lead .....        | $\frac{1}{2}$ pound. |
| Boiling water .....          | 8 gallons.           |

Let settle and draw off clear liquor for use. To 1 gallon water add  $\frac{1}{4}$  ounce of first product for bath for cotton goods. Add  $\frac{1}{4}$  ounce for silk or wool. Immerse 24 hours or more, then six hours or more in second compound (D).

Proofing compound:

Mixture 1.—Dissolve in water, 50 parts alum; also dissolve in water, 35 parts sugar of lead; mix.

Mixture 2.—Combine 17 parts paraffine and 35 parts benzine; drop into this 17 parts Caoutchouc. Stir until well dissolved.

Mixture 3.—To the clear decanted liquor from the above mixtures, add 8 parts alcohol and 4 parts eau de cologne (or oil of lemon).

An English compound for waterproofing textile fabrics: Sugar soap, 1 pound; water, 16 gallons. Soak articles in them for 6 hours; drain, but do not wring them; and place them in the following solution:

Alum, 1 pound; water, 16 gallons; soak again 6 hours, take out and dry without wringing.

Another English compound for waterproofing textile fabrics: Concentrated size, 8 pounds; aluminum sulphate, 5 pounds; barium chloride, 6 pounds; water, 16 gallons. After coating, varnish with the following: Melt together 22 pounds colophony, 4 3-5 pounds crystallized soda, and 11 pounds water. Then add: Ammoniacal fluid, 5½ pounds; and water, 55 pounds; or: Borax, 6 pounds; shellac, 6 pounds; and water, 40 pounds.

A German compound for waterproofing woollens: Dissolve 100 pounds alum in moderate quantity of boiling water; soak 100 pounds glue till it has taken up twice its weight of cold water, then apply heat to dissolve it; stir 5 pounds tannin and 2 pounds soluble glass well into the glue, then add the alum solution. Enter the goods at 80° C., and steep 30 minutes. Take out and drain several hours, stretch on a frame, and, when dry, calender.

A German shower-proof compound: Stir 9 pounds casein well in 32 quarts water, adding little by little 25 pounds of slaked lime. Add a solution of 4½ pounds soap in 26 quarts water.

Filter and treat the cloth with the liquid. Dress with a dressing of acetate of alumina, by which the casein is rendered insoluble in the fibers of the cloth. After two applications, rinse the goods with hot water, press strongly, and dry.

One process for waterproofing threads and yarns used in weaving ducks and other fabrics is in two parts, the first of which relates to a tanning mixture in which the yarns are immersed, consisting of: Birch bark, 14 pounds; bichromate of potash, 1 pound; chloride of calcium, ½ pound; tar 1 pint; solution of alkali, 2 pounds. The threads are first boiled in a 5 per cent. solution of alkali to destroy perishable matter, after which they are immersed in the tanning liquid and dried. The second part consists of preparing or dressing the threads with the following compound:

Poppyseed oil, 2 gallons; India-rubber solution, 2 pounds; red oxide of mercury, 1 pound; resin, 28 pounds; beeswax, 28 pounds; palm oil, 14 pounds. The threads after this treatment are wound on reels for weaving.

Forster, as far back as 1847, made a water-repellent compound in which he used spermaceti, wax, and stearine, while three years prior to that Townsend used two solutions to accomplish that end, the first being water, calcined British gum, white soap, logwood liquor, and rock alum; the second being water, sulphate of zinc, calcined British gum, and palm soap.

The Kyanized cloth process is well known in connection with preserving fabrics, the treatment being with a mixture of corrosive sublimate, chloride of zinc, pyrolignite of iron, oil of tar, and resinous matters. Fabrics treated in this way have been used for the manufacture of hose.

Crape cloth is a fabric which has much the appearance of real crape, but is far less expensive. It is treated with processes similar to the Cravenette process, which make it both waterproof and durable. Two patents for this process have been granted to W. E. B. Priestly.

According to Dr. Doremus the lightest fabrics are rendered unflammable by dipping them in a solution of phosphate of alumina in water.

Allard's fireproof felt is made of 50 per cent. of asbestos and 50 per cent. of animal hair, and for ordinary purposes is wholly fireproof.

Canvas for sails and other purposes, which it is desired to render waterproof, is treated by the Dumas process so that, while it is both waterproof and fireproof, it is still elastic and permeable by air. The treatment is this: The material is first put in a solution of gelatine, then run through pressure rollers, and spread in the open air to dry; later it is dipped in a cold solution of alum again exposed to the air, then washed in cold water, and finally dried.

Frankenburg's waterproof cloth is made in this manner: Both warp and woof are coated in the yarn with India-rubber, then powdered with farina, then woven, after which the fabric is calendered, and the result is a cloth that is thoroughly waterproof, and yet does not give evidence of having rubber in its make-up.

Smith's porous waterproof fabric called for a compound made of 100 parts of paraffine melted by heat, to which was

added 15 per cent. of India-rubber, the mixture being kept from 5 to 30 minutes at a temperature of 100° C. The solution, either as it is, or with a solvent, is then transferred to the cloth by means of a set of rollers which have a temperature of about 70° C.

**AMPHIBOLINE.**—A natural earth found in Germany, which once mixed with water, will not mix again. Used with a small amount of gelatine for waterproofing.

**Cohuru's waterproofing compound.** This consists of crude petroleum, 3 quarts; liquid asphalt, 1 pint; white drier, 1 pint; beeswax, 4 ounces, and gum-arabic.

#### DEODORIZATION.

THE odors that cling to vulcanized rubber goods and to Gutta-percha are often very objectionable, and the following processes are given for deodorization:

**Cattell's process:** For every pound of well cleaned Gutta-percha take 15 pounds of the following solution: Benzol, 1 gallon; alcohol, 1 ounce; glycerine, 30 drops. Or: Benzole, 1 gallon; nitrate of the oxide of ethyl, 30 drops; heat in a closed vessel to 110° F. The Gutta-percha is recovered by cooling to below 32° F., and pressing or by distilling off the solvent, or by precipitation with fusil oil.

**Freeley's process:** Dip vulcanized rubber goods in a solution of: Salicylic acid, 20 grains; alcohol,  $\frac{1}{2}$  pint. This will deodorize them, but goods will be toughened and the deodorization increased by subjecting goods to a bath in hot or cold solution composed as follows:

(A) Bark of oak, 50 pounds; bark of hemlock, 50 pounds; bark of sumac, 50 pounds; water, 900 gallons.

(B) Solution as above, 2 gallons; salicylic acid, 20 grains; large tablespoonful of Russian Jackten extract, dissolved in 2 pints of alcohol, 1 pint of ether, and 10 grains of salicylic acid.

**Bourne's process:** The articles to be deodorized are placed between layers of charcoal and heated from 120° to 150° F., if unvulcanized; 180° F., if partially vulcanized; or 212° F., if completely vulcanized. Heat for six hours or more.

**Lavater and Tranter's process:** Subject the articles to a boiling in potash, then to a vacuum, then to a pressure of air



scented with some essence. They claim the extraction of the sulphur from the pores of the rubber in the form of sulphureted hydrogen and its replacement by perfumed air.

Charles Hancock's process: To remove the odor of Gutta-percha, steep it in the following solutions:

(A) Soda or potash, 1 pound; water, 10 gallons.

(B) Chloride lime, 1 pound; water, 10 gallons.

De la Granja's process:

Iodine .....	15 grains.
Permanganate of potassa .....	20 grains.
Iodide of potassium .....	60 grains.
Glycerine .....	4 ounces.
Sulphite of soda .....	4 ounces.
Sulphite of lime .....	4 ounces.
Sulphite of potassa .....	4 ounces.
Water .....	1½ to 2 gallons.

Steep or macerate rubber in a solution composed as above, in a close earthen vessel, 24 hours, the solution being cold. Then heat the solution gradually to boiling point and uncover the vessel until  $\frac{1}{3}$  of weight of solution evaporates. When the solution cools remove the rubber.

The Traun Rubber Co. patented a process for adding powdered perfumes to India-rubber, the stock being used for dental dam, dress shields, and the like.

#### PRESERVING RUBBER GOODS.

THE deterioration of vulcanized rubber goods is often a serious matter, where it is necessary for some time to keep them in store. Wherever possible, they should be kept in a cool dark place, and away from warm currents of dry air. It has been advised that such goods as druggists' sundries be stored in an airtight receptacle in the bottom of which is placed a vessel containing benzine, which is allowed to evaporate slowly. Kreusler and Bude in *Der Techniker* recommend the dipping of the articles in a paraffine bath, heated to about 212° F. This does not injure the color or the appearance, but is said to enable the goods to effectually resist both light and atmospheric influences. From its well known softening effect on India-rubber, however, paraffine is likely to be used with considerable care by rubber manufacturers. In the line of mechanical goods, Turner patented a process for

treating both hose and tubing with carbolic acid, either during its manufacture or after vulcanization in order to preserve it. Torrey also saturated duck with carbolic acid before it was made up into hose.

Mowbray's process for preserving rubber in valves: The use of 20 pounds of India-rubber, washed and cut fine, in connection with 5 to 10 pounds of naphthaline; digest 24 to 48 hours, at 180° to 230° F. Masticate in a machine heated to 212° F., until it forms a plastic homogeneous compound. If other substances are to be added, treat as follows:

1. Soluble matters (sulphur, antimony, resins, etc.) dissolve in naphthaline, melted or boiling, and add to above naphthalized caoutchouc at temperature of 240° F.

2. Materials insoluble in naphthaline (oxides of lead and zinc, chalk, etc.) deprive of moisture and heat to 212° F. and add to naphthalized caoutchouc.

This compound can be used for soft or hard rubber, according to the proportion of sulphur used. The object is to preserve the elasticity of rubber and prolong its durability.

Trueman's process for preserving India-rubber, and fibers that may be used with it, employs the peroxides of manganese and lead and the black oxide of copper, all of which have the property of decomposing ozone in great quantity, and converting it into oxygen. The inventor believes that ozone is the active agent in producing decay, and, by changing it into oxygen, he arrests such decay. In applying these oxides, he mixes them with ozocerite or tar.

Elworthy patented a process for storing rubber goods in a receptacle filled with nitrogen, hydrogen, marsh gas, or carbonic acid gas. This was recommended especially for rubber goods in India.

Benton (American patent) describes the following: A composition for preserving India-rubber, consisting of one part turpentine as much camphor gum as the turpentine will readily dissolve, and one part linseed oil proportioned to the combined part of turpentine and camphor gum.

Truss (English patent) advises: A mixture of 95 parts of soda-ash and 5 parts of commercial carbonate of ammonia is

dissolved in hot water and applied to India-rubber articles to preserve or restore them.

Zingler's process treats decayed rubber goods by long solution in boiling water containing tartar emetic; mixed afterwards with tannic acid and calcium sulphite.

#### FASTENING RUBBER TO METALS.

THE problem often comes to rubber manufacturers as to how to stick rubber or rubber compounds to iron so that they will not part from it, no matter under what strain. This is done successfully by a number of different formulas. Where the processes are skilfully carried out, the rubber should adhere so firmly to the iron, that it will disintegrate and give way anywhere else in the mass, except where its surface is in contact with metal. The basis of all these processes is said to be the chemical affinity for sulphur which is in the rubber with the copper salts used in the compound. One formula for this is: First, the grinding of the iron, finishing it with a file, and dipping it in strong lye to remove all grease, and afterward in muriatic acid or dilute sulphuric acid heated in water. The metal is cemented before the rubber is applied.

The process patented by Garrity and Avery, is as follows: Nitric acid (41° Beaume), 10 gallons; muriatic acid (22° Beaume), 10 gallons; mix and add pure tin, finely divided, 10 pounds.

Immerse the iron for 8 seconds, remove and dip into weak solution sulphuric acid, then wipe with a woollen cloth. Then apply with brush or otherwise, the following compound: Rubber cement 7½ gallons; litharge, 6 pounds; and sulphur, 3 pounds. Add vulcanizable rubber compound at once, and vulcanize.

Hall's process: Water, 100 quarts; caustic potash, 10 pounds; cyanide of potash, 2 pounds; sulphate of copper, 2 pounds; sulphate of zinc, 2 pounds. The pickle and bath are made of water and about 10 per cent. sulphuric acid, the tub being lined with brass plate.

Adam's process: A weak solution of sulphate of copper is made—say 2 or 3 ounces of the crystallized salt to the gallon—and this solution may be acidulated with sulphuric acid—say

about  $\frac{1}{2}$  gill of strong acid to the gallon. For a fine film for "dipping" articles of iron, steel, or tin, to which the rubber compound is to be applied, if the metal is copper, it should first be coated with tin, nickel, or iron.

The shellac process calls for a cement made of shellac steeped in ten times its weight of concentrated ammonia, the solution being allowed to stand three or four weeks. This solution is painted on the iron, allowed to dry, and the rubber vulcanized upon it.

#### THE USE OF GASES.

BEFORE India-rubber reached its present value in the arts, and before coal gas was generally known as an illuminant, Mol-lerat obtained oil of caoutchouc by distillation and made a fine quality of illuminating gas from it. It is needless to say that the process is not practiced to-day.

Pellen rendered India-rubber impervious to gas by coating it with collodion mixed with a very small quantity of castor oil or with a varnish composed (1) of 32 per cent. of gum arabic, 8 per cent. of sugar, and 60 per cent. of water, or (2) made from 28 per cent. of dextrin, 60 per cent. of water, and 12 per cent. of gelatine.

Bousfield rendered vulcanized India-rubber impermeable to gas by applying linseed oil to it in the form of a varnish, the articles being heated.

Parkes suspended articles to be vulcanized in a dry heater and passed the following gases into the chamber as a means of vulcanization: Sulphurous acid, gas, chlorine, nitrous acid, or the vapors of bromine or iodine.

Charles Hancock cured rubber by the action of vapors produced by dissolving zinc, copper, or mercury in nitric acid. The action of these vapors being so solvent, only one or two moments were given, and the surfaces then washed in an alkaline solution.

Nickels passed sulphur fumes and hydrogen into the gum while in a masticator, curing afterward by heat.

Johnson prepared carburet of hydrogen from oil of tar as a solvent for Gutta-percha. In order to overcome the smell of the solvent, he added a little alcohol in which was essence of lavender.



Hughes made an artificial rubber from gelatine, resin, oil, and tannin, improving the compound by exposing the compound to the action of hydrogen, sulphurous gas, sulphureted hydrogen, nitrous gas, or ammonia.

Brooman treated vulcanized waste rubber with vapors of turpentine in his reclaiming process.

Lake bleached India-rubber in a stream of ammonia gas or chloride of ammonia, afterwards thoroughly washing the gum in hot water.

A great many rubber goods—that is, thin sheet goods—are cured by what is known as the vapor process. This is done in many cases by hanging the goods in an air-tight chamber, like a dry heater, and passing the vapor, which is either that of chloride of sulphur alone, or chloride of sulphur mixed with carbon bisulphide, into the curing room. Small articles are often put in a tumbling barrel made of wire, which revolves slowly in the vulcanizing room, thus giving the vapor a chance to do its work thoroughly. The rubber surfaces are of course dusted first, to keep them from adhering. Proofed cloth is cured in vapor by passing the rubber surface over troughs in which this reagent is slowly evaporating.

The vapors of ozocerite are also used in rendering cloth water-repellent.

Vulcanized India-rubber, whether compounded or pure, is permeable by gas. In making flexible gas tubing, therefore, it must be coated or in some way protected in order to make it gas tight. The common way of accomplishing this is to cover the rubber tube with an outer tube made of glue, glycerine, and bichromate of potash, this covering being protected in turn by a woven fabric. Another plan for accomplishing the same result is to have an outer and inner tube of India-rubber, between the two being vulcanized a sheet of tin-foil.

#### ACTION OF METALS ON RUBBER.

THE action of various metals on India-rubber has always interested rubber manufacturers. In the memoirs and proceedings of the Manchester (England) Literary and Philosophical Society 1890-91, William Thomson, F.R.C., and Frederick

Lewis published an exceedingly interesting paper on this subject. They covered almost all of the metals that are likely in any way to come in contact with rubber surfaces, and proved what has long been acknowledged by rubber manufacturers, that the action of copper is most harmful. The metals that have no action at all on rubber are gold, silver, bismuth, antimony, arsenic, tin, chromium, iron, nickel, cobalt, zinc, and cadmium. Those that act only in a slight degree on rubber are lead, aluminum, palladium, and platinum.

Of the salts of metals that are very destructive, copper stands first, manganese oxides and nitrate of silver, being, however, almost as bad. Several other nitrates have also an injurious effect, although not as much so as those just mentioned. They are the nitrates of ammonia, uranium, sodium, and iron.

According to N. Foden, a well-known English expert, proofed goods in browns have caused him more trouble by deterioration than any other colors—more than black, even—and it is to be said right here that blacks as a rule are viewed with distrust by manufacturers, because it is believed generally that copper salts are used in the dyeing. Mr. Foden instances the time when brown tweeds were used largely, and when most manufacturers experienced a great deal of trouble with them, as the browns showed early signs of decay, while the grays remained soft and flexible. Mr. Foden suggests that, as certain dyers use lime, which is cheaper than logwood, this may act destructively upon the rubber.

#### ARTIFICIAL RUBBER MILK.

WHEN rubber in solution of almost any of the ordinary solvents is mixed with a moderately large quantity of methylated spirit, it is precipitated and forms later a sticky, whitish mass from which the resins and coloring matter have been taken by the spirit. Instead of this process, Lascelles-Scott advises the following: Take a 10 or 15 per cent. solution of fine Para rubber in benzine or chloroform with a little strong alcohol, but not enough to precipitate the rubber. If a considerable volume of tepid water be then quickly stirred into the solution, the rubber slowly separates from its solvent. If to this be added a little resin-potassa

soap, with a little liquor ammonia, the emulsion is very similar to rubber milk. The distinguished author suggests the use of potassa soap made of the native rubber resin as the best emulsifying compound for such a purpose.

In writing on the preservation of genuine rubber milk, he also condemns the use of creosote, for, although it prevents fermentation, it does not hinder the gum from separating. He advises the use of ammonia and if it is to be kept through hot weather, the addition of a fragment of camphor or naphthaline or a few drops of santal-wood oil.

Thermophoric Mixture.—Tiemar (Germany), patents the following: A thermophoric mixture comprising thermophoric salt, dissolved sunflower seed, Greek hay-seed (*Faenum Graecum*) or similar vegetable-seeds which contain viscous substances and a fat which will not affect India-rubber and the like material.

Zieger and Weigand (British patent) cover a process for exposing dipped goods, after each dipping, to air-dried bi-calcium chloride or by cooling.

Rendering vulcanized rubber adhesive.—Raymond's patent consists of treating India-rubber with benzine or a substance having an analogous action thereupon, then immersing the rubber in a solution of permanganate of potassium and a suitable acid, and again treating the rubber with benzine or a substance having similar action thereon.

Rubber Sponge.—The Harburg-Vienna Rubber Co. patent the following: Unvulcanized India-rubber is mixed with natural seeds, or with molded bodies of flour, clay, gelatine, sugar compositions, or other substances, or with non volatile soluble metallic salts, either by rolling, or by first dissolving the India-rubber in a hydrocarbon. The mixture is vulcanized, and the added bodies are subsequently washed out with water, acids, or alkalies.

Refining Gutta-like Gums.—Willmowski's patent consists in dissolving the gum in hot petroleum naphtha, removing the insoluble parts, cooling the solution until the gum itself is precipitated while the resins remain in solution. Then washing the precipitated gum in cold petroleum naphtha, which removes soluble parts, and then evaporating the naphtha from the remaining purified gum.

**Crude Rubber Purifying**—British patents of Thame and the South Western Rubber Co.—Rubber is first soaked in hot dilute caustic potash, and then immersed in a solvent. When partially in solution the tank is filled with water. After 18 to 24 hours the liquid is removed and the rubber washed with boiling water.

**Banana Rubber Process**.—Bananas are washed and cut cross-wise, and the liquid extracted in a centrifugal machine. The India-rubber separates from the liquid on standing. British patent by Zurcher, of Jamaica, West Indies.

## SHRINKAGE OF RUBBER.

THE following table shows the average rate of shrinkage in the various leading grades of India-rubber, and also the widest range of shrinkage noted in the practice of some extensive manufacturers. The figures express percentages in weight:

	Average	Range
<b>Para sorts:</b>		
Fine .....	16 to 18	15 to 20
Medium .....	17 to 19	16 to 22
Coarse .....	22 to 28	18 to 35
Mangabeira .....	25 to 30	20 to 35
Caucho .....	26 to 34	20 to 40
Centrals .....	26 to 32	20 to 40
<b>Africans:</b>		
Tongues .....	19 to 24	18 to 25
Flakes .....	28 to 33	25 to 35
Thimbles .....	22 to 28	15 to 35
Accra sorts .....	24 to 32	20 to 40
Congo sorts .....	19 to 24	18 to 35
Benguela sorts .....	16 to 20	16 to 20
Mozambique sorts .....	17 to 28	10 to 35
Madagascar sorts .....	30 to 40	25 to 55
Assam .....	23 to 31	8 to 45
Borneo .....	33 to 38	30 to 45

Mr. T. Bolas, in his "Cantor lectures" on India-rubber, in 1880, gave the following estimates of shrinkage of these leading grades:

Para .....	15 per cent.
Para negroheads .....	25 "
Ceara .....	28 "
Guayaquil .....	40 "
Borneo .....	25 "
African ball .....	25 "
African tongues .....	35 "
African niggers .....	25 "
Madagascar .....	25 "



## PARA RUBBERS.

The next table indicates in detail the percentage of shrinkages in the various grades of Para rubber, also determined by the practice of American manufacturers:

	Fine	Medium	Coarse
Bolivian .....	15 to 17	16 to 18	20 to 25
Mollendo .....	15 to 17	16 to 18	.....
Madeira .....	15 to 18	16 to 19	20 to 25
Manaos .....	16 to 17	17 to 18	18 to 22
Upriver .....	16 to 18	17 to 19	18 to 25
Matto Grosso .....	16 to 18	17 to 19	20 to 28
Angostura .....	16 to 18	17 to 19	25 to 30
Caviana .....	16 to 18	18 to 20	25 to 30
Itaituba .....	17 to 18	18 to 19	20 to 25
Islands .....	18 to 20	18 to 22	25 to 35
Cameta .....	.....	.....	30 to 35

The shrinkage of Mangabeira (Pernambuco) thin sheet is about 25 to 30 per cent.; thick sheet, 30 to 35; ball, 20 to 25. Caucho (Peruvian) slab, 30 to 40; sheet, 30 to 35; strip, 25 to 35; ball, 20 to 25.

The better grades of Centrals shrink from 25 to 30 per cent.; other grades, generally from 30 to 40.

## AFRICANS.

The Gold Coast sorts (including Accra, Cape Coast, Saltpond, Addah, Quittah, and Axim) range about as follows: Buttons or biscuit, 20 to 30; flake, 30 to 35; lump, 30 to 40; niggers, 20 to 35.

Cameroon ball, 18 to 25; clusters, 18 to 28.

Lagos buttons, 25 to 35; lump, 30 to 40; strip, 25 to 35.

Congo buttons, 25 to 30; ball No. 1, 20 to 25; ball No. 2, 25 to 35; Upper Congo ball and strips, 20 to 35; red ball, 18 to 22; Equateur small ball, 16 to 20; mixed ball, 18 to 22; Lopor small ball, 16 to 22; Kassai black twist, 18 to 22; red twist, 20 to 25; ball, 20 to 25.

Benguela (and Loanda) sausage, 16 to 20; niggers, 18 to 20.

Mozambique (including Lamu) ball No. 1, 10 to 15; ball No. 2, 15 to 25; ball No. 3, 25 to 35; sausage, 20 to 35.

Madagascar pinky, 30 to 35; Majunga, 30 to 35; black, 30 to 40; niggers, 30 to 40.

## SHRINKAGE OF RUBBER.

## EAST INDIAN.

Assam No. 1, 10 to 15; No. 2, 20 to 30; No. 3, 30 to 35.

Penang, No. 1, and Java No. 1, 10 to 15 per cent.; other numbers same shrinkage as Assam.

E. Chapel gives this table of percentages of shrinkage:

Para, fine .....	12	Ceara .....	28
Para, coarse .....	25	African ball .....	28
Loando .....	17	Madagascar .....	28
Colombia .....	20	Assam .....	28
Java .....	22	Gaboon .....	35
Gambia .....	24	Borneo .....	35

## TO FIGURE SHRINKAGE IN CRUDE RUBBER.

It is strange that there should be a divergence of opinion and method in arriving at the net cost of rubber after washing, sheeting, and drying it, yet such is the case. To assist those who have not studied this question, the right and the wrong way of figuring on shrinkage is given here. Take, for instance, an average-priced rubber:

*Example A.*

100 lbs. rubber at \$0.50 = \$50.00  
20 lbs. shrinkage = 20 per cent., or 1-5th.

80 lbs., net cost \$50.00, as above.

80 ) 50.00 ( 62.50

48 0

200

160

400

400

Some persons, however, figure in this way:

*Example B.*

100 lbs. at \$0.50 lb.

Shrinkage 20 per cent. = 1-5th.

\$0.50 + 1-5th (10 cents) = 60 cents.

*Example A.*—Correct method—net cost ..... \$62.50

*Example B.*—Incorrect method—net cost ..... 60.00

Difference ..... \$2.50

This is a difference of 4 per cent., which, if it occur in manufacturing a large amount of goods where rubber is the greater part of the compound, would make quite a difference in the profit.

## SPECIFIC GRAVITY OF RUBBER.

THE following records of the specific gravities of different samples of India-rubber have been collected:

Best Para, taken in dilute alcohol (Ure) .....	0.941567
Best Assam, taken in dilute alcohol (Ure) .....	0.942972
Best Singapore, taken in dilute alcohol (Ure) .....	0.936650
Best Penang, taken in dilute alcohol (Ure) .....	0.919178
Caoutchouc (Julian) .....	0.920000
Crude caoutchouc of India (Adriani) .....	0.966800
Black caoutchouc (Adriani) .....	0.945200
Prepared from juice in pure state (Faraday) .....	0.925000
Determined by E. Soubeiran .....	0.935500
Determined by Payen .....	0.925000

H. L. Terry, F.I.C., gives the specific gravity of Para rubber and refers to Faraday's figures as being most correct.

Faraday's general analysis of the latex of the *Hevea* is:

Caoutchouc .....	30.70
Albuminous extractive and saline matter .....	12.93
Water .....	56.37

The specific gravity of the latex quoted was 1.012.

The crude rubber itself is made up of the following general composition: Carbon, 87.5; hydrogen, 12.5.

## CHAPTER XIV.

### PHYSICAL TESTS AND METHODS OF ANALYSIS OF VULCANIZED INDIA-RUBBER.

It long has been the boast of expert rubber superintendents and manufacturers that they found little trouble in matching compounds. As a matter of fact, some of them are marvelously expert. Given a small sample of vulcanized rubber in a familiar line, with a knowledge of the price at which it must be produced, they are able in a majority of instances, by their knowledge of rubber and of compounding ingredients, to get a result that is apparently similar, and without much experimenting.

In certain instances, however, they fail, principally where a new product is brought in for matching, to which is attached an extraordinarily low price. The usual refuge in such a case formerly was the assertion that the manufacturer was losing money on that particular line of goods. But this has been so often disproved, and the sample found to be both an original and better compound, that this excuse is not often heard nowadays.

The factory expert gaged his sample, no matter how expert he might be, by purely physical rules. The smell told him what kind of rubber was used, whether Para or African, and usually whether reclaimed rubber was present. The strength and the weight of the sample gave him an indication as to the amount of adulteration. The color also had its suggestions as to material contained in it, but the knowledge thus shown often was very far from being exact.

Nor was the general result very much better when information was purchased from employes, or points secured through quizzing the supply men. The best course for the rubber superintendent to pursue, therefore, is to put his knowledge up against that of the expert chemist, when the two, working together, can usually match better than the original. It is better if the chemist be familiar with the practical manipulation of rubber, for the unfamiliar chemist has in many cases brought science into considerable disrepute in the factory.

Certain rubber compounds, in spite of the most careful analy-



sis by expert chemists, have remained, and probably will remain, profound secrets. For ordinary work, however, there ought to be no trouble in getting a fair analysis. The following descriptions of processes employed in the analysis of vulcanized rubber are given chiefly that the rubber superintendent who views chemistry as a dark and deep mystery may have some knowledge of what the chemist is about when he seeks his assistance. Before beginning on chemical analysis a few words more concerning physical tests may not be amiss.

In the case of many kinds of goods there is a great variety of appliances that form really valuable tests as to their durability, tensile strength, wearing quality, and so on. As a rule, these aim to reproduce the work that the vulcanized article is obliged to endure in actual service. In rubber boots and shoes, for example, a machine is employed which bends the shoe exactly as it is bent when the wearer is walking, and at the same time gives a friction motion on the sole. This is run at a high rate of speed, so that a week's wear on a machine like this would correspond to a month of service in actual use.

A machine is also used for testing air-brake hose which counterfeits the swing and kinking motion that the hose gets in actual service. This is run at a very high rate of speed, and the hose which stands this sort of usage longest is supposed to be adapted to endure the longest time in actual use.

Tires, both pneumatic and solid, are tested by being put on a wheel rim and run what is equivalent to hundreds and thousands of miles over roughened surfaces upon which they are pressed by a lever carrying heavy weight. These mechanical contrivances are valuable in showing the severe usage that rubber will often stand, but none of them are exact parallels to absolute service, for as a rule they are more severe, particularly in the intense heating that may come to the rubber from high speeds and great friction.

Manufacturers and purchasers of rubber goods have also many simple and excellent tests for approximating the value of the rubber. In belt and hose covers and tubes, a bit of the rubber is cut from the fabric and stretched to show its tensile strength. The fabric is also pulled apart, and the integrity of the friction

proved by the way it resists such separation. Rubber springs sometimes have been placed under a steam hammer which was allowed to drop upon them, the results being noted and that compound standing up longest being considered the best.

An English manufacturer following out this test, got some interesting, if not valuable, results. He took a piece of vulcanized India-rubber  $1\frac{1}{2}$  inches thick and with 2 inches area, and placed it under a steam hammer of five tons, which first rested upon the rubber without effect. The hammer was then raised two feet and dropped upon it without injury, then lifted four feet, when the cake was torn, but none of its elasticity was destroyed. More severe trials were then made. A block of vulcanized India-rubber was placed between two cannon balls, with the whole power of the heaviest steam hammer employed; the iron spheres split the block, but the elasticity of the rubber still remained.

The ordnance department of the United States government some years ago inaugurated some very interesting tests of vulcanized rubber at the arsenal at Watertown, Massachusetts, the results of which are appended:

No. 1.

Applied Loads.	Mean Length.	Compression.	Compression Sets.	Middle Diameter.
<i>Pounds.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inch.</i>	<i>Inches.</i>
0	5.72	....	....	6.10
1,000	5.32	.40	0.	6.38
2,000	4.84	.88	.10	6.72
3,000	4.47	1.25	.18	7.06
4,000	4.03	1.69	.29	7.48
5,000	3.70	2.02	.33	7.79
6,000	3.40	2.32	.37	8.12
7,000	3.14	2.58	.42	8.44
8,000	2.96	2.76	.39*	8.73
9,000	2.80	2.92	.51	8.92
10,000	2.68	3.04	.58	9.11
11,000	2.60	3.12	.52*	9.24
12,000	2.50	3.22	.60	9.42
13,000	2.45	3.27	.67	9.55
14,000	2.36	3.36	.73	9.68
15,000	2.31	3.41	.74	9.77
0	5.15	....	....	6.71

\* Before these sets were taken the load on the rubber was reduced to 500 pounds, then increased to 1,000 pounds, and the sets then measured.

The second test was of new rubber gun-carriage springs, in which the compression sets were determined under the initial load, the end diameters approximate under load. The length of the rubber spring was 6.03 inches; the diameter 6.03 inches; the diameter of core 1.04 inches; the sectional area 27.71 square inches; and the weight 11 pounds:

No. 2.

Applied Loads.	Length.	Compression.	Compression Sets.	Diameters.		Middle Diam. Under Initial Load.
				End.	Middle	
<i>Pounds.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inch.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
500	5.87	0.	0.	6.03	6.12	6.12
1,000	5.70	.17	.02	6.03	6.24	6.15
1,500	5.51	.36	.03	6.03	6.35	6.15
2,000	5.34	.53	.06	6.03	6.48	6.18
2,500	5.13	.74	.07	6.03	6.64	6.18
3,000	5.00	.87	.07	6.10	6.76	6.18
3,500	4.81	1.06	.09	6.15	6.87	6.18
4,000	4.65	1.22	.08	6.16	7.00	6.18
4,500	4.50	1.37	.08	6.18	7.15	6.19
5,000	4.35	1.52	.02	6.29	7.26	6.19
5,500	4.20	1.67	.12	6.38	7.41	6.19
6,000	4.06	1.81	.19	6.43	7.55	6.19
6,500	3.95	1.92	.03	6.50	7.66	6.21
7,000	3.83	2.04	.15	6.64	7.77	6.21
7,500	3.70	2.17	.15	6.70	7.91	6.22
8,000	3.62	2.25	.15	6.78	8.02	6.22
8,500	3.52	2.35	.16	6.89	8.13	6.22
9,000	3.43	2.44	.16	6.96	8.24	6.23
9,500	3.35	2.52	.17	7.06	8.34	6.24
10,000	3.25	2.62	.17	7.25	8.46	6.25

The spring was then removed from the testing-machine, measured, and its length was 5.90 inches; middle diameter 6.08 inches. After it had rested 20 minutes the length was 6 inches, and the middle diameter 6.06 inches. It was then placed again in the testing machine and the figures on the following page taken.

When removed its measurements were: Length 5.86 inches; middle diameter 6.24 inches; end diameter 5.90 inches; the ends were concave, V. sine .06 and .08 inches. After six hours' rest it recovered in length to 5.96 inches.

## No. 3.

Applied Loads.	Length.	Compression.	Compression Sets.	Diameter.		Middle Diam. Under Initial Load
				Ends.	Middle.	
<i>Pounds.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inch.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
500	5.84	.03	.03	6.01	6.15	6.15
6,000	4.00	1.87	..	6.55	7.63	....
10,000	3.29	2.58	..	7.25	8.40	....
10,500	3.21	2.66	..	7.35	8.48	....
11,000	3.16	2.71	..	7.39	8.54	....
11,500	3.11	2.76	..	7.46	8.60	....
12,000	3.06	2.81	.17	7.55	8.67	6.26
13,000	2.94	2.93	..	7.74	8.86	....
14,000	2.86	3.01	..	7.86	8.97	....
15,000	2.80	3.07	.22	7.94	9.04	6.30
16,000	2.71	3.16	..	8.10	9.20	....
17,000	2.65	3.22	..	8.20	9.28	....
18,000	2.61	3.26	..	8.27	9.35	....
19,000	2.56	3.31	..	8.36	9.42	....
20,000	2.53	3.34	.30	8.43	9.47	6.37

In the next test the length of the spring was 6.06 inches; diameter, 5.97 inches; diameter of core 1.06 inches; sectional area 27.11 square inches; weight, 11 pounds.

## No. 4.

Applied Loads.	Length.	Compression.	Compression Sets.	Diameter.		Middle Diam. Under Initial Load.
				End.	Middle.	
<i>Pounds.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inch.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
500	5.90	0.	0.	5.97	6.07	6.07
1,000	5.75	.15	.02	5.97	6.16	6.07
1,500	5.59	.31	.02	5.97	6.27	6.08
2,000	5.41	.49	.06	5.98	6.38	6.10
2,500	5.25	.65	.05	6.02	6.48	6.10
3,000	5.05	.85	.09	6.05	6.62	6.12
3,500	4.90	1.00	.08	6.08	6.73	6.11
4,000	4.76	1.14	.10	6.14	6.88	6.12
4,500	4.61	1.29	.10	6.20	7.00	6.12
5,000	4.47	1.43	.11	6.25	7.11	6.12
5,500	4.33	1.57	.11	6.31	7.24	6.14
6,000	4.21	1.69	.12	6.37	7.32	6.15

The measurements when removed from the machine were: Length, 5.98 inches; middle diameter 6 inches; end diameter 5.97 inches. After it had rested 15 hours, it measured: Length 6.02



inches; middle diameter 6 inches; end diameter 5.96 inches. It was then placed again in the machine and tests were resumed.

No. 5.

Applied Loads.	Length.	Compression.	Compression Sets.	Diameter.		Middle Diam. Under Initial Load.
				End.	Middle.	
<i>Pounds.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inch.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
500	5.90	0.	..	5.97	6.08	6.08
6,000	4.27	1.63	..	6.35	7.30	....
6,500	4.12	1.78	.08	6.38	7.41	6.11
7,000	4.00	1.90	.09	6.60	7.55	6.12
7,500	3.90	2.00	.10	6.57	7.62	6.14
8,000	3.82	2.08	.10	6.65	7.73	6.12
8,500	3.72	2.18	.11	6.75	7.82	6.14
9,000	3.62	2.28	.14	6.84	7.93	6.16
9,500	3.52	2.38	.14	6.93	8.03	6.17
10,000	3.45	2.45	.16	7.00	8.11	6.17

The spring was then removed from the testing machine and its measurements were: Length 5.92 inches; middle diameter, 6.09 inches. Measurements after the spring had rested one hour showed: Length, 5.98 inches; middle diameter, 6.06 inches; end diameter, 5.95 inches. The spring was again placed in the machine and tests resumed.

No. 6.

Applied Loads.	Length.	Compression.	Compression Sets.	Diameter.		Middle Diam. Under Initial Load
				End.	Middle.	
<i>Pounds.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inch.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
500	5.88	0.7	.07	5.97	6.13	6.13
6,000	4.09	1.81	..	6.41	7.47	....
10,000	3.46	2.44	..	7.00	8.12	....
10,500	3.38	2.52	..	7.09	8.22	....
11,000	3.34	2.56	..	7.15	8.27	....
11,500	3.27	2.63	..	7.21	8.36	....
12,000	3.17	2.73	.22	7.26	8.40	6.22
13,000	3.10	2.80	..	7.46	8.57	....
14,000	3.02	2.88	..	7.51	8.67	....
15,000	2.90	3.00	.26	7.66	8.70	6.27
16,000	2.84	3.06	..	7.84	8.95	....
17,000	2.79	3.11	..	7.90	9.02	....
18,000	2.75	3.16	..	7.97	9.06	....
19,000	2.70	3.20	..	8.05	9.13	....
20,000	2.68	3.22	.37	8.11	9.19	6.36

(THE PRECEDING TABLE CONTINUED.)

Applied Loads.	Length.	Compression.	Applied Loads.	Length.	Compression.
<i>Pounds.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Pounds.</i>	<i>Inches.</i>	<i>Inches.</i>
1,000	5.43	.47	11,000	3.05	2.85
2,000	5.10	.80	12,000	2.98	2.82
3,000	4.75	1.15	13,000	2.91	2.99
4,000	4.43	1.47	14,000	2.85	3.05
5,000	4.10	1.80	15,000	2.81	3.09
6,000	3.80	2.10	16,000	2.78	3.12
7,000	3.58	2.32	17,000	2.74	3.16
8,000	3.38	2.52	18,000	2.70	3.20
9,000	3.25	2.65	19,000	2.67	3.23
10,000	3.15	2.75	20,000	2.63	3.27

Time for loading, three minutes. The spring was then removed from the testing machine and its measurements showed: Length, 5.81 inches; middle diameter, 6.25 inches; end diameter, 5.87 inches; ends concave, V. sine, .08 and .10 inch. It recovered in length to 5.93 inches after four hours' rest.

The French navy also inaugurated a series of tests for rubber belting which are of interest. The first test related to elasticity. Samples from the cover were first put into a steam vulcanizer for 48 hours, under a pressure of 5 atmospheres, which they should stand without losing their elasticity. The samples are then placed under a pressure of 85.5 pounds per square inch on the grating of a valve box, and given strokes at the rate of 100 per minute. They were expected to stand 9,100 strokes, while samples not tested by the steam should stand 17,100 strokes. Strips from the cover that had received the steam treatment, 6-10 of an inch square on cross section, and 8 inches long, fastened at each end and elongated 3.9 inches, were not expected to break when stretched 8 inches more, this being repeated 22 times a minute for 24 hours. Strips that had not been treated to the steam bath should resist the same treatment for 100 hours. These tests of course applied to high grade compounds only.

The analysis of vulcanized India-rubber should give the following information:

Amount of India-rubber,  
Amount of India-rubber resins,  
Amount of substitutes,

Amount of free, fatty resin, and mineral oils, resin, paraffine, and bituminous bodies,

Amount of sulphur of vulcanization,

Amount of sulphur and chlorine in substitute,

Amount of free sulphur,

Amount of mineral matters.

The mineral matters embrace metallic sulphides and oxides, inert mineral substances such as whiting and barytes, and substances imparting special properties such as asbestos, graphite, pumice, etc.

According to Carl Otto Weber, Ph.D., F.C.S., and to Percy Carter Bell, F.I.C., F.C.S., Dr. Robert Henriques has by his methods of analysis solved the problem that troubled the analysts more than any other, which was that of determining the amount of oil substitutes found in India-rubber compounds.

Dr. Henriques's methods are as follows: Fuming nitric acid to the amount of 20 c.c. is placed in a small dish covered with a funnel, through the stem of which 3 to 4 grams of rubber are slowly added. When the action has ceased, the dish is warmed gently on a water bath until the contents are of the consistency of a thin syrup. There are then added 4 grams of a mixture of 4 parts sodium carbonate and 3 parts of potassium nitrate, after which it is carefully fused, and treated with dilute muriatic acid, then evaporated to dryness to render silica, if present, insoluble, redissolved by adding a little nitric acid, and, last, the sulphuric acid is precipitated with barium chloride. The residue of silica may contain sulphates of lead or of barium. Ammonium acetate dissolves the former.

In estimating the sulphur of vulcanization, and also the excess of sulphur, they must be separated from that present in the form of sulphates and sulphides. This is done in the following manner: The sample of rubber is dissolved in that fraction of ordinary petroleum which distills over at from  $140^{\circ}$  to  $250^{\circ}$  C., being kept in the solvent at a boiling temperature for two days. From 5 to 15 grams of the sample are placed in a weighed flask, and, after adding about 150 c.c. petroleum free from sulphur, all the inorganic matter is dissolved by heating the flask with reflux condenser at about  $150^{\circ}$  C. The subsequent processes are the filtering of the solution, the careful washing of the flask with hot

petroleum, and the rinsing of both flask and filter with petroleum ether. Those substances insoluble in petroleum are determined by weighing on the tared filter at 110° C.

The sulphur in this residue, which is easily determined, when deducted from the total sulphur of the sample, gives the amount of the free sulphur, and sulphur of vulcanization. If the rubber contains metallic oxides or carbonates, some of the sulphur may have been oxidized to sulphuric acid, and the results noted above may be too low.

The rubber substitutes in the compound are completely and easily soluble in alcoholic potash. The following is the manner of this analysis: From 3 to 5 grams of the rubber compound, finely divided, is boiled for about 8 hours in ten times its weight of alcoholic soda, 8 per cent. strong. The solution, diluted with water, is freed from the alcohol by means of a water bath, after which the residue on a weighed filter is washed, dried, and weighed. To determine the residue on ignition of the extracted residue, one gram is taken and the ignition performed in the presence of ammonium nitrate. If now the substance extracted from the rubber be free from chlorine, it may either consist of free oil, or be derived from black rubber substitute. In the latter case, it must contain at least 10 per cent. of sulphur, but in the former, only traces of sulphur will be present. An estimation therefore of the chlorine and of the sulphur in the alcoholic extract determines the presence of white substitute, black substitute, or sulphur.

In using caustic alkali a certain amount of the alkali will be retained, the amount of which must be determined, if correct figures are to be secured. Repeated washings in dilute muriatic acid remove this, and allow of its determination.

The following data are necessary in the analysis of vulcanized rubber containing substitute or oil: (1) The total sulphur; (2) the total ash; (3) the weight of the substance after extraction with alcoholic soda; (4) the sulphur, the ash, and the sulphur in the extracted fatty acids all to be found in the third substance. Also, the weight of the substance after extraction with alcoholic soda. From 1.5 to 2 grams of substance are used, the extraction being twice repeated, each boiling being from two to



three hours. The quantity of rubber dissolved by the alcoholic soda is deducted from the weight of the total extract. This correction averages 2.5 per cent.

From the above figures, the percentage of rubber and fatty acids may be calculated by equations, which read:

$$\text{Rubber} = \frac{100}{97.5} \left( \text{Weight of substance after extraction of alcoholic soda} - \text{its sulphur} - \text{its ash} \right).$$

The fatty acids from this equation:

$$\text{Fatty acids} = 100 - (\text{total sulphur} + \text{total ash} + \text{percentage of rubber found from the foregoing equation}).$$

The sulphur contained in the rubber substitute is represented by assuming that quantity to be about equal to that of the fatty acids in white substitute and about 1.5 per cent. larger than the quantity of fatty acids in brown substitute. The difference between the total sulphur and the sulphur in the substitute is the sulphur of vulcanization. Asphalt being often present in rubber compounds, by first dissolving the free sulphur by treatment with alcoholic soda, and then dissolving the asphalt out by means of nitrobenzene, it is easily determined. The presence of mineral oils, paraffine, and resins are the only things that interfere with this means of extraction.

The following tests are credited to C. A. Lobuy de Bruyn:

1. Extract Test (Henriques's method).—Three grams of the finely divided sample when boiled for six hours with 50 c.c. of a 6 per cent. alcoholic solution of caustic soda should not lose more than 8 per cent., the loss to be calculated upon the organic substance of the sample. The extract should contain sulphur and rubber resins.

2. Dry Heat Test.—Two grams of the finely divided sample are heated to 135° C. for two hours. When cold the sample should not have suffered any alteration and should show a loss of weight not exceeding 1.5 per cent.

3. Moist Heat Test.—A small piece of the sample is sealed in a glass tube half filled with water. The tube is then heated to 170° C. for four hours. The sample should not be affected by this treatment.

4. Ash.—About 1 gram of the sample is fused, decomposed, and partly ignited over a small flame in a porcelain crucible. The heat is then increased and ignition completed.

Dr. C. Reinhardt, in *Dingler's Polytechnisches Journal*, writes as follows on the analysis of vulcanized India-rubber: "The determination of the ashes is effected by gradually heating in a covered crucible .0182 ounce of the product until the cessation of gaseous liberation. The calcination is finished in an open crucible, care being taken not to heat too much, so as to avoid the losses due to the volatilization of the substances composing the ashes. To determine the proportion of mineral substances (with the exception of sulphur) .0182 ounce of India-rubber fragments is moistened with 1.2 cubic inch of D nitric acid ( $= 14$ ), and heating takes place in a water bath for five to seven minutes, until complete dissolution ensues. Dry evaporation takes place in the water bath, followed by moistening with hydrochloric acid and dissolution in water. The residue is formed of sulphate of barium and silica acid; the quantitative analysis of the substances contained in the liquid (oxide of zinc, lime, magnesia, oxide of iron, and alumina) being made according to the usual methods. To determine the total of sulphur there is treated .0357 ounce of the product (while heated) with 1.2 cubic inches of nitric acid; chlorate of potash being gradually added until oxidation is complete. After evaporation and dissolution in water, with the addition of hydrochloric acid, follows precipitation. Then takes place the quantitative analysis of the sulphuric acid by the chloruret of barium and of the remainder of the sulphuric acid in the insoluble residue of sulphate of baryta. It is possible to determine the quantity of sulphur added for the vulcanization by burning the product in a current of oxygen at a low temperature by passing the vapors across hydrochloric acid containing bromine, and by analyzing quantitatively the sulphuric acid formed in the condition of sulphate of baryta. The India-rubber can likewise be distilled in glass tubes and the quantity of sulphur in the distilled liquor can be ascertained."

In Dr. Weber's exceedingly valuable article printed in the *Journal of the Society of Chemical Industry*, the steps in analysis are thus shown:

SUMMARY OF WEBER'S METHODS OF ANALYSIS.

I. Acetone (10 runs in Soxhlet tube).

Fatty and Mineral Oils, Resins and Free Sulphur.	II. Boiling Alcoholic Soda (8 per cent).			
	Rubber Substitutes.	III. Cold Nitrobenzole.		
		Asphaltum.	IV. Boiling Nitrobenzole (Soxhlet tube).	
			Rubber and Sulphur of Vulcanization.	V. Residue.
				Mineral matters and free carbon.

The rubber substitutes are determined by extracting in alcoholic soda solution and asphaltum by cold nitrobenzene, both of these methods being Henriques's. The rubber is separated by extraction with boiling nitrobenzene in the Soxhlet tube. Starch is dissolved out by boiling water. The mineral and carbonaceous matters are determined in the final residue. The matters in the acetone extract, the rubber and mineral matters are determined by weighing after evaporation. Substitutes and asphaltum are best determined in the loss of weight operated upon.

Of the various forms of sulphur occurring in rubber, the determination of free sulphur and sulphur of vulcanization is of great importance. The estimation of the free sulphur is made in the acetone extract. Not all the sulphur in this extract is free, as the presence of rubber substitutes in the sample means that the extracts will contain sulphides of the fatty acids, also the sulphides produced by the action of free sulphur on the resins always found in rubber. To estimate the sulphur in the acetone extract, add 20 c.c. of a solution of pure sodium sulphide and caustic soda and heat the mixture on a water bath for an hour. Dilute the solution with warm water, and precipitate the fatty acids by adding a slight excess of barium hydrate. Filter, wash, and make up the filtrate to 300 c.c. and estimate the sulphur in an aliquot part.

In determining the sulphur of vulcanization, the free sulphur must first be removed, and for this purpose, the acetone extract answers very well. In every case the sulphur of vulcanization should be estimated direct. The solution of rubber in nitrobenzene is therefore distilled under reduced pressure. The flask containing the non-volatile residue is then dried at  $140^{\circ}\text{C.}$ , and then oxidized with fuming nitric acid. When the residue has finally dissolved, the solution is poured into a platinum dish, the flask being rinsed with warm nitric acid. The residue is then evaporated on the water bath, fused with carbonate of soda, dissolved in water, oxidized with bromine, acidulated with muriatic acid, and the sulphur precipitated with barium chloride. The sulphur in the asphaltum which is in the cold nitrobenzole solution is determined in a similar manner.

#### TORREY'S METHOD OF DETERMINING RUBBER.

JOSEPH TORREY, PH.D., who has added much to rubber research, uses the following method for examining both vulcanized and unvulcanized rubbers:

- "1. Oils, resins and free sulphur—Acetone extract.
- "2. Pitch, tar, asphalt, etc.—Pyridine extract on residue from 1.
- "3. Oily substitutes—Alcoholic soda extract on residue from 2.
- "4. Mineral matter—Residue from and nitro naphthaline extraction of residue from 3, or by incineration.

"I have not included the 'sulphur of vulcanization' determination because in very many cases it is not important, or can be judged closely enough. It would however, be convenient to have a short method of determining in the residue from 3—or a portion of it—the amount of pure rubber present.

"The methods described by Weber and Harries, apart from the recent criticisms by Alexander and Harries, are long and expensive. They require, moreover, no small amount of manipulative skill. I venture, therefore, to submit the following as a simple and inexpensive method requiring little apparatus and capable of yielding good results in comparatively untrained hands.

"Let it be distinctly understood, however, that I do not offer



this as a suitable method for valuing crude rubber, though I have in many cases obtained good results by its use. If such a method is desired the precipitation method recently described by Fendler gives quick and satisfactory results, as I have found in several years' experience with it.

"The new method is founded on the fact that when rubber is heated with pure nitric acid of specific gravity 1.42 under fairly constant conditions it is converted into a body which dissolves completely in caustic alkaline solutions with production of a deep red color. I have not studied this body in detail, except to satisfy myself that the same weight of pure rubber, when treated as described and diluted with water to a definite volume, always gives the same tint. It makes no difference whether the rubber be vulcanized or not, in the ordinary filling and weighing mineral bodies used in vulcanized rubber goods have no effect on the final tint.

"Resins sometimes interfere, sometimes not. Dark substitutes interfere, and must be removed. Pitch, tar, asphalt, etc., also interfere. The proper place for the determination is after No. 3 in the scheme given above. I will now describe the preparation of a rubber solution of known strength, and having a convenient standard tint; and then show how the solution thus prepared is used as a standard of comparison with other solutions similarly prepared, but containing unknown amounts of rubber.

"0.1 gram of pure, precipitated rubber is placed in a test tube and treated with 2 c.c. of pure nitric acid, specific gravity 1.42. The tube is placed in a beaker of water heated to 50-60° C. till the action is entirely over; then to 90-100° for 20 minutes.

"Add first 10 c.c. distilled water, then 20 c.c. of caustic soda solution (1 part stick caustic soda in 4 parts water). Stir or shake gently; dilute with 10 c.c. more water, filter, and wash the filter paper with water till the washings are colorless. Finally dilute the whole to 250 c.c.; mix thoroughly, and transfer about 100 c.c. to a test tube of, say, 120 c.c. capacity. This solution represents a concentration of 0.1 gram rubber in 250 c.c. and has a straw tint which experience shows to be a convenient one.

"Suppose now that we have in hand the residue from operations 1, 2, and 3, we proceed with it as follows:

"Weigh carefully 0.1 gram and treat with 2 c.c. of nitric acid, specific gravity 1.42, in exactly the same way as just described. Add the same quantities of water and caustic soda solution as before, filter, and wash till the washings are colorless. Finally transfer the solution (or half of it if the tint is very deep) to a test tube having the same internal diameter as that contained in the standard; and dilute, with constant stirring, till the standard tint is exactly matched. Measure carefully the volume of the solution under test. Call it V. Then the calculation of the percentage of rubber in the original mixing is accomplished by the equation—

$$P = \frac{a \ V}{250}$$

Where  $P$  = The percentage required.

$V$  = The volume of the solution under test when at standard tint.

$a$  = 100 per cent. minus the total percentage lost in operations 1, 2 and 3.

"If only half the test solution has been diluted this result must, of course, be doubled. The results are good. Duplicates usually agree with 0.5 per cent. A table is appended showing a few results.

"As to the composition of these samples, I will merely say that they contain no substitutes and no tarry substances. The rubber used was a good Borneo, containing 1.5 per cent. resin. The content of rubber according to the proportion in which the materials were weighed out would be from 40 to 50 per cent., but I do not feel at all sure that one can assume that a mixing, especially when vulcanized, contains the calculative proportion of unaltered rubber.

"I have had about four months' experience with the method, and the best evidence of its trustworthiness is that in every case where I have been lead to results which I at first distrusted, the final outcome has been the discovery of unsuspected circumstances which vindicated the accuracy of the suspected results.

"Finally, it may be pointed out that the determination of mineral matter not easy at all by any of the present methods can, by making use of the direct determinations indicated in the above

plan of analysis, be made the only factor determined by difference. I am of the opinion that results obtained by this method will be found fully as trustworthy as those by any method at present known."

Sample Number.	Unvulcanized.	Vulcanized.
No. 1 .....	47.26	47.00
	47.43	47.19
No. 2 .....	41.92	41.18
	41.36	41.74
No. 3 .....	45.89	46.19
	44.93	45.12
No. 4 .....	47.75	47.00
	47.39	47.56
No. 5 .....	47.19	47.39
	46.62	46.43
No. 6 .....	49.26	49.44
	48.52	49.82

Test for Farina in Rubber.—Those manufacturers who now and then receive lots of Para rubber adulterated with the starch like meal of the mandioc or cassava plant—also called farinha flour—may be interested to know of the method of detecting such adulteration employed by Mr. Walter E. Piper. Starch is a characteristic test of iodine, forming with it a deep blue compound. Mr. Piper uses a solution in water of iodine and potassium iodide, which is applied with a brush to the interior of a "ham" of fine Para. If there is farinaceous matter present it will speedily take on a bluish appearance. Ordinarily the adulterant is not visible, and the manufacturer becomes aware of it only from the extra loss in washing rubber.

Analyses of Caoutchouc molecules.—Professor Dr. C. Harries's experiments show that ozone may be readily added to the Caoutchouc molecule, and he proved that there are two double sets of bonds for  $C_{10}H_{16}$ . The "Ozonite" obtained is an explosive body and it has a chemical formula of  $(C_{10}H_{16}O_8)_2$ . Professor Harries analyzed this "ozonite" into levulinic acid, which is an acetone, and which is a derivative from succinic acid. The mystery which has surrounded the Caoutchouc molecule has by this work been unveiled.

## CHAPTER XV.

### GUTTA-PERCHA—ITS SOURCES, PROPERTIES, MANIPULATION, AND PRINCIPAL USES.

GUTTA-PERCHA, which was introduced into Europe from Singapore in 1843, was for a while confounded with India-rubber, from which it differs in some very important particulars. It becomes soft and plastic on immersion in hot water, retaining the shape then given it on cooling, whereupon it becomes hard, but not brittle like other gums. India-rubber, on the other hand, does not soften in hot water, and retains its original elasticity and strength unimpaired. The water, as such, exercises no softening action on Gutta-percha, the effect being purely one of temperature, which may equally well be produced by hot air, only somewhat more slowly. The degree of heat required depends upon the quality of the material, but even the hardest kinds become plastic above 150° F. Heated in air considerably above the boiling point of water, Gutta-percha decomposes and finally ignites, burning with a luminous smoky flame and emitting a pungent odor resembling that from burning rubber. If heated in a vacuum, gaseous and liquid products are obtained similar to those resulting from the distillation of rubber. The liquid which distills over consists chiefly of hydrocarbons of the terpene series, which form an excellent solvent for Caoutchouc. The two most important are *isoprene* and *caoutchine*, which are identical with the liquids by the same names obtained from India-rubber. Since these products can also be obtained from other sources, Dr. Eugene Obach and others have observed that they may yet form a stepping-stone in the synthetical production of India-rubber and Gutta-percha from the lower terpenes.

A curious physical characteristic of Gutta-percha is that when it has been softened in water, although it is so plastic that it will reproduce the most delicate impressions, it will bear blows from hammers or allow itself to be thrown against a stone wall without being at all marred. The reason for this is that it contains a large amount of air. By placing the



Gutta-percha under a bell jar immersed in mineral oil, when a vacuum is produced, a large amount of air is evolved from the gum, and it will be found to have lost the property of hardening on cooling, its substance being like a tough greasy leather.

Nowhere on the globe have genuine Gutta-percha trees been found outside of a rectangular area embracing portions of the Malay peninsula, Borneo, Sumatra, and some adjacent smaller islands. Strange to say, the occurrence of these trees has not been established in Java, or the Celebes, though trees producing inferior qualities are found in the Philippines. These trees belong to the natural order *Sapotaceæ*; the principal genera and species will be noted further on.

According to Payen's analysis, verified by later chemists, Gutta-percha contains three components: (1) a substance insoluble in cold and in boiling alcohol, which he termed pure *gutta*; (2) a crystalline white resin, soluble in hot, but not in cold alcohol, which he called *albane*; (3) an amorphous yellow resin, which he named *fluavile*. Pure gutta is insoluble in ether and light petroleum spirit at ordinary temperatures, whereas both *albane* and *fluavile* dissolve readily in them. Gutta possesses all the valuable qualities of Gutta-percha, but in a much enhanced degree; it becomes soft and plastic on heating, and hard and tenacious on cooling without being in the least brittle. But the resins themselves are either soft at ordinary temperatures, or, when hard, quite friable. It is, therefore, gutta which forms the useful constituent of Gutta-percha, and the resins are only accessory components, which, although admissible, and perhaps even desirable in a comparatively small amount, yet have a decidedly detrimental effect when they preponderate. Hence, in order to determine the technical value of a sample of Gutta-percha, it is necessary first to learn the relative proportion or ratio between gutta and resins. There must also be taken into account the *water* enclosed in the mass, and the coarse impurities—wood fibers, bark, sand, etc.—which are described as *dirt*. These components represent the loss or waste to the manufacturer.

While the relative proportion of gutta and resins forms an

important criterion for estimating the commercial value of a sample, it is not in itself sufficient. Although the analysis of two different specimens may give the same result, the physical and mechanical properties, and, most important of all, the durability, may differ widely, owing to a difference in their molecular constitution. It will thus be seen that there are guttas and guttas. In addition to the qualitative analysis, it is necessary to scrutinize the gutta itself, which requires much judgment and experience. Analyses have been made of specimens which contained eight times as much gutta as resin; others contained about an equal amount of both, and in others still the amount of resin was three times that of gutta. Samples in which the percentage of resin reaches that of gutta, or surpasses it, are of a decidedly inferior description. These differences are due doubtless to the fact that the Gutta-percha of commerce is derived from trees of various species, and also in part to the treatment which the gum receives at the hands of the gatherers, who are suspected of mixing the product of different trees, to say nothing of adulterations of a more debasing character.

The commercial classification of Gutta-percha is less satisfactory than that of India-rubber, since no standards have become fixed in the markets. While Para rubber, for instance, may be bought and sold by means of established designations, "Islands fine," "Upriver fine," and the like, no such practice exists with regard to Gutta-percha. Since all transactions in the latter are based upon samples, trade names and brands are little considered. However, "Macassar," and "Banjermassin," which are the names of districts producing Gutta-percha, were used formerly to indicate the highest quality, while "Sumatra" sorts were supposed to be less valuable, and "Borneo" the lowest of all. In a sense these designations have become merely commercial, no longer affording any indication of the origin of the Gutta-percha. At the same time, "Macassars" and "Banjermassins" might vary with every new arrival, so that one was not certain, in buying one of the sorts named, to obtain particularly good Gutta-percha; it might have been the very opposite.

Innumerable sorts appear in the Singapore market—which

is the center of the Gutta-percha trade—but Dr. Obach selected twelve of the principal brands as typical of all the rest, and divided them into four groups, for convenience in comparison, the best being named first. They are as follows, the designations being derived either from the countries of their origin or from the places of export:

- |      |   |   |
|------|---|---|
| I.   | { | 1. Pahang—from the Malay peninsula.               |
|      | { | 2. Bulongan red—from Macassar, Borneo.            |
|      | { | 3. Banjer red—from Banjermassin, South Borneo.    |
| II.  | { | 4. Bagan goolie soondie—from Borneo.              |
|      | { | 5. Goolie red soondie—from Serapong, Borneo.      |
|      | { | 6. Serapong goolie soondie—from Serapong, Borneo. |
| III. | { | 7. Bulongan white—from Macassar, Borneo.          |
|      | { | 8. Mixed white—from Borneo.                       |
|      | { | 9. Banjer white—from Banjermassin, South Borneo.  |
| IV.  | { | 10. Sarawak mixed—from Borneo.                    |
|      | { | 11. Padang reboiled—from Sumatra.                 |
|      | { | 12. Banca reboiled—from Banca.                    |

Group I comprises the three best kinds, derived from trees of the genus *Dichopsis* (known in continental Europe as *Palaquium*). Group II comprises three kinds of the second order, derived probably from the genus *Payena*. Group III embraces the so-called "white gutta," of second and third grade, mostly of uncertain origin, but probably from *Dichopsis polyantha*. Group IV is made up of mixed materials, two of them being what is termed "reboiled" (an operation performed by the Chinese traders, who buy up odd lots, soften the materials in hot water, and make them into a more or less homogeneous average mixture). The "Sarawak mixed" lots mostly represent a very useful second-class material; the "reboiled" is decidedly inferior. This classification is based upon the results of 751 analyses of mixed lots, representing over 5,000,000 pounds of raw Gutta-percha, made by Dr. Obach, with a view to arriving at the relative proportions of gutta, resin, dirt, and water contained. The cleanest kind is the "Sarapong soondie," which contains only  $3\frac{1}{2}$  per cent. of dirt, but it is rather wet, having more than 25 per cent. of water. One of the least favorable materials is "Banjer white," which contains 33.1-3 per cent. of water and 15 per cent. of dirt, making in all nearly 50 per cent. of waste. When a raw material is very dirty and wet, it is noticeable on cutting the blocks open, and this is now the rule in the Singapore market. The blocks are then

sorted out into several grades (two or three, sometimes more) according to their appearance, and valued accordingly.

A grade of Gutta-percha which is nearly white in color and very brittle is apt to contain a large percentage of resin, which, as already explained, renders it of little value. In explanation of some of the terms in the preceeding classification, it may be said that Gutta-percha is obtained principally by cutting down the trees and ringing the bark at intervals of 12 to 18 inches along the trunk. The milky sap soon fills the grooves cut into the bark, and, in the better varieties, soon coagulates, when it is scraped off with a knife. In the case of inferior sorts, the milk requires more time to curdle, and has to be caught in receptacles placed under the tree. The collected milk is then gently boiled, either by itself or with the addition of water. The material obtained without the use of water is called a *goolie*, the other a *gutta*; but the two kinds are often mixed together. The goolie is more compact than the gutta, and has a dough-like smell. The word soondie is derived from the Malay term "Gutta-sundek," which is applied to the product of trees of the *Payena* species already referred to.

The processes employed by manufacturers for cleaning raw Gutta-percha are either *mechanical* or *chemical*. Those of the first class will first be considered. Generally speaking, the raw Gutta-percha is either first cut up in a slicing machine and then softened in hot water, or the lumps are placed directly in hot water and the soft material transferred to the washing machine. There it is washed with hot water for a longer or shorter time, and then passed through a strainer. Next, as a rule, it is washed once more, then put into a kneading or masticating machine, to consolidate it and remove the mechanically enclosed water, and finally it goes to the rolling mill, to be made into sheets.

The slicing machine or chopper now used is pretty much the same as that proposed by Charles Hancock, of England, in his patent (No. 11, 575, O.L.) of 1847, except that it is provided with a greater number of fluted and serrated knives, instead of only three plain ones, fixed in the slots of a heavy iron disc. The blocks of Gutta-percha are packed into a trough and then forced against the rotating disc, the knives in which cut the material into thin slices.



The washing machine consists of an iron roller of star-shaped section, enclosed in a cylindrical shell provided with one or two projections, or ribs, against which the Gutta-percha is forced in going round. The cylindrical shell is enclosed in a large iron case, filled with water, which is heated by means of direct steam. The dirt, as it is washed off, falls through the lower part of the cylindrical shell into the outer case, whence it is drawn off once in a while. This machine is developed from that described in the English patent of R. A. Brooman. (No. 10,550, O.L.)

The Gutta-percha leaves the washing machine in a plastic state and passes to the straining machine—a strong iron cylinder with a perforated bottom, on which a number of discs of fine wire gauze have been placed. It has a piston which is driven home by hydraulic power, at a pressure of 1,500 to 2,000 pounds per square inch, squeezing the soft Gutta through the meshes of the gauze.

The kneading machine or masticator resembles the washer, except that the roller is smaller in diameter, and the flutings are more numerous and not so deep. The Gutta-percha is kept hot during mastication and the water escapes in the form of steam through openings at the top.

The mixing machine, introduced by Paul Pfeiderer, is similar to that used in the India-rubber, linoleum, and other similar industries. It is provided with peculiarly-shaped blades, working against one another. The machine is used for mixing the various sorts of Gutta-percha, in order to obtain a material of any requisite properties, and also for blending Gutta-percha with pigments or other ingredients. The rolls can be heated by steam, but heat is developed by the kneading process itself, and care must be taken not to overheat the material.

The Gutta-percha is next rolled into sheets, usually between  $\frac{1}{8}$  and  $\frac{1}{4}$  inch, and cut into lengths of 5 or 6 feet, and stacked away for use. The rolling machine takes the material from the mixer and squeezes it between parallel rollers, running it back and forth until it is cool and hard enough for cutting up.

The average percentages of waste, shown by numerous analyses of the twelve brands of Gutta-percha catalogued on a preceding page, are about as follows:

Pahang .....	34	Bulongan white .....	43
Bulongan red .....	35	White mixed .....	35
Banjer red .....	44	Banjer white .....	47
Bagan goolie soondie .....	32	Sarawak mixed .....	44
Goolie red soondie .....	27	Padang reboiled .....	44
Serapong soondie .....	36	Banca reboiled .....	29

The difference in the quality of various brands of Gutta-percha, measured by the relative proportions of gutta and resin, has already been mentioned. Of the sorts mentioned above, "Banca reboiled" shows a comparatively small loss in cleaning, but it is the least valuable on the list, being low in gutta, whereas "Pahang," though losing more in the cleaning process, is by far the most valuable sort in the market, because so rich in gutta. Gutta-percha imported in recent years loses more in cleaning than formerly; Dr. Obach, in 1898, estimated the loss as almost twice as great as formerly.

The chemical washing process was suggested by Charles Hancock, in an English patent, in 1846. He steeped raw Gutta-percha, cut into small pieces, in a solution of caustic alkali or chloride of lime, to neutralize the acidity and remove any unpleasant odor. His experiments showed that the alkaline treatment not only reduced the percentage of dirt—that is, it was better cleaned than by the mechanical process—but lessened the capacity of the Gutta-percha for retaining mechanically enclosed water. But the treatment with chemicals requires great care and judgment, and thorough subsequent washing with water; otherwise the material will be rendered perishable.

Chemicals were also used by Obach for hardening Gutta-percha. The really valuable constituent of Gutta-percha being the gutta, the more a sample contains of the latter, the better it is, provided the gutta itself is of a good description. For certain purposes it is advantageous to improve the hardness and other mechanical properties of Gutta-percha, and this can be done by extracting the resin with a suitable solvent, which leaves the gutta itself intact. The raw Gutta-percha is first chopped and thrown on drying platforms gently heated from below by steam pipes. Or the pieces may be thrown into a rotating drum heated by currents of warm air. They then go to a series of tanks in which petroleum spirit is used as a solvent for the resin. The spirit

becomes charged with the resinous matters, and the resulting solution is distilled off, after which the material remaining is masticated as in the case of any other Gutta-percha. A specimen treated by this process will remain quite hard under a temperature which will render other specimens soft and plastic. Other liquids may also be used, as ether, and a saturated solution of carbon disulphide in alcohol.

Instead of removing impurities from Gutta-percha by washing it either with water or an alkali, this can be done by dissolving the material into a suitable liquid, straining or filtering the solution, and then evaporating the solvent. Carbon disulphide has been used as the solvent, but with the effect of rendering the Gutta-percha perishable.

Recently an article known as Green Gutta-percha has been offered to the trade, being extracted from the leaves of the trees. Several systems for extracting Gutta-percha from leaves have been described. That of Dieudonne Rigole involves the use of carbon disulphide; that of Eugene Serullas the use of hot toluene as a solvent, after which the Gutta-percha is precipitated by means of acetone, instead of distilling off the solvent; and that of Obach the use of light petroleum spirit as a solvent for leaves that have been previously crushed between rollers, the gum being reprecipitated from the solution on cooling below 60° F. The author of each process has devised apparatus for its operation.

Many trees produce gums which have been experimented with in the hope that they would prove good substitutes for Gutta-percha, but none have proved of value except the "bullet" tree, which yields Balata. The gutta contained in Balata is very strong and tough, being of excellent quality; but the percentage of resin is large, and the material can be regarded as a substitute only for second-class, or perhaps even third-class, Gutta-percha. Balata is somewhat more flexible than Gutta-percha containing an equal amount of resin, which appears to be due to the softness of the resinous constituents. On becoming heated Balata behaves much like ordinary Gutta-percha. If plunged into boiling water it becomes quite soft and plastic. If next immersed in cold water, it slowly hardens again, but still remains flexible and elastic, showing no signs of brittleness. Analyses of specimens of Balata from

British Guiana, obtained from the London docks in 1889-94, showed an average loss of 13.8 per cent. of water, and 9.9 per cent. of dirt, or a total of 23.7 per cent. of waste. The respective percentages of gutta and resin were 41.4 and 34.8.

The specific gravity of cleaned Gutta-percha is practically the same as that of water, though varying with the relative proportion of gutta and resin, becoming lower as the percentage of resin increases. It may be affected, also, by the constitution of the resin and also of the gutta. The softening temperature of Gutta-percha depends entirely upon the ratio of gutta and resin. A specimen of which 60 per cent. was resin was softened at the temperature of 48° C. to the same extent as another specimen, containing only 2½ per cent. of resin, for which a temperature of 55° C. was required. The time for the material to become hard again, after having previously been softened in hot water, depends in a like degree upon the proportion of gutta and resin. But the principal mechanical property of Gutta-percha with which the manufacturer has to deal is the tensile strength. A specimen having 45 per cent. of gutta and 55 per cent. of resin will break under pressure of 770 pounds to the square inch, whereas for another specimen, after most of the resin has been extracted with petroleum spirit, nearly twice that breaking strain would be required. As for the elongation of Gutta-percha—*i. e.*, the extent to which it will stretch before breaking—it is also affected by the percentage of resin, being in the last two cases, for instance, 490 and 500 per cent., respectively, but it also depends on the nature of the gutta.

The earliest practical use of Gutta-percha was for surgical appliances—for bandages, splints, and receptacles for vaccine virus. It is used for ear trumpets; for the handles of surgical instruments, as it affords a firm grip and is preferable to wood for antiseptic reasons; in medicine, in the form (1) of a very thin tissue, (2) of sticks, and (3) of a 10 per cent. solution in chloroform; for chemical purposes, in the form of tubes, pumps, syringes, bottles, and the like, and for ladles and tubes for handling caustic alkalies and corrosive acids and liquids in chemical works; and for mechanical purposes, as rings and cups for pumps and hydraulic presses and for driving-bands (belting). For the



latter purpose Balata is also used largely, interposed between canvas; such belts can be joined by means of a solution of Balata or Gutta-percha in carbon disulphide. Another application of Gutta-percha is that for taking impressions of medals, and also of the interior of large guns. Gutta-percha is also modeled into ornaments in the shape of the leaves and petals of flowers, this being done by working the gum by hand in hot water with one or two simple iron tools. Such ornaments are often applied to the decoration of jars made of semi-porous ware, the whole being painted afterward.

But the most important application of Gutta-percha is in the insulation of submarine and subterranean cables. Dr. Werner von Siemens first proposed Gutta-percha for insulating purposes in 1846, and in the next year he designed a screw-press, for the seamless covering of wires with that material, which is still in existence, while the principle of the press is still adhered to. Gutta-percha has been found to be very permeable to the X-rays, and it has been proposed to utilize this property to examine Gutta-percha-covered wires for the detection of defects in the copper conductor, particularly in "joints," or for finding air-bubbles. The X-rays may also be used for the detection of large foreign bodies in the raw Gutta-percha. Up to the end of 1907 no less than 248,000 miles of submarine cables had been laid, either commercial in character or government owned, embodying the use of Gutta-percha of a weight estimated at 32,000 tons. A further allowance must be made, for underground cables, street wires, etc., of 8,000 tons. The length of Gutta-percha-covered wires under the streets of London alone, some time ago, was 17,000 miles, corresponding to 375 tons of Gutta-percha.

The electric properties of Gutta-percha depend chiefly on the nature of the gutta and to a less extent upon the resin; but only very slightly on the relative proportion of these two components. They depend also upon the nature and amount of the impurities and on the water. The insulation resistance and inductive capacity are little affected by the extraction of the resin. The insulation should be as high as possible, and the inductive capacity, for most purposes, as low as possible, but whereas the latter is mostly associated with other good qualities of the material, such

is not always the case with a high insulation. A third electric property is called dielectric strength, or resistance to piercing by high voltages. A thickness of a little over  $\frac{1}{8}$  inch of Gutta-percha breaks down with 40,000 volts, and one of about 1-10th inch with 28,000 volts.

Gutta-percha hardened by the extraction of its resin is used chiefly in the manufacture of golf balls. Gutta-percha for this purpose should be tough, elastic, and not brittle at low temperatures; it should be specifically lighter than water, in order not to sink if dropped accidentally into a ditch. It is requisite that the proper grade of raw material be chosen and that the resin be extracted as completely as possible. To test the elasticity of golf balls, a machine is used, consisting (1) of a perpendicular scale, divided into feet and tenths; (2) a clip, at the top, for holding the ball to be tested; and (3) an iron plate at the bottom. The object is to measure the rebound of the ball, when released from the clip and falling upon the plate. A ball made of Gutta-percha, of which 25 per cent. was resin, rebounded only to the point on the scale marked 30; a ball containing only 10 per cent. of resin rebounded to 45; and still another, having only a small percentage, rebounded to 60—the highest point reached. A ball of Balata, having the resin thoroughly removed, rebounded to 59.

Some figures will give an idea how greatly the physical and mechanical properties of Gutta-percha are affected by the extraction of the resin. Carefully selected specimens of a medium quality were cut fine and intimately mixed, and then divided into two portions. One portion was next washed in the ordinary way with water; the other treated with petroleum spirit until nearly all the resin had been extracted. The two specimens showed the following analyses:

	Gutta.	Resin.	Dirt.	Water.	Total.
Cleaned in ordinary way	54.7	39.4	2.7	3.2	100
Same material, hardened	93.0	2.8	2.5	1.7	100

The different physical and mechanical properties of the two specimens are indicated in the next comparison:

	Ordinary.	Hardened.
Temperature when commencing to soften	37.7°C.	57.2°C.
Temperature when commencing to harden	58.8°C.	91.1°C.
Time of hardening .....	17 min.	45 sec.
Tensile strength—pounds per square inch	1592	5662
Elongation—per cent. ....	360	285

The electrical properties, on the other hand, are but little affected, the insulation being practically the same as before, and the decrease of specific inductive capacity is probably due to the smaller percentage of water in the hardened material.

The principal cause of the destruction of Gutta-percha is the absorption of atmospheric oxygen, which alters the gutta and produces a brittle resin of quite a different nature to that originally present in the material. This destructive oxidization is greatly assisted by light, and by other causes—for instance, by any action tending to make the material porous, such as alternate wetness and dryness, the presence of substances which exercise a solvent action on Gutta-percha as a whole, or any of its components. Certain alkaline substances and decaying organic matters also appear to act injuriously, but frequently it is impossible to assign a definite cause for the decay of Gutta-percha. It is, however, not merely manufactured Gutta-percha which undergoes these destructive changes, for raw material of the very best kind succumbs in time to the combined action of light and air. On the other hand, specimens of Gutta-percha are in existence which, after proper means of protection, have remained in good condition for more than fifty years. Complete immersion in water affords a good protection, for which reason submarine cores of Gutta-percha are more safely placed than underground wires. Another way of excluding the air, to some extent, is to varnish the Gutta-percha articles. When Gutta-percha is oxidized it becomes porous and full of cracks. If it be used for insulating wires, the insulation fails at such places, since the moisture penetrates the pores and fissures and establishes an electric contact with the conducting wire.

Some compounds containing Gutta-percha are very useful for different purposes, and a specially useful one, consisting of a mixture of Gutta-percha, colophony, and Stockholm tar, is known as "Chatterton's compound." It is used largely in connection with the manufacture of Gutta-percha-covered wires, as a binding material between the copper conductor and the Gutta-percha covering, or between the different layers of Gutta-percha on the core.

Willoughby Smith patented the following compound for

insulating wires: One-fifth by weight of Stockholm tar and about the same weight of resin are put into a vessel with a jacket (or, preferably, a series of pipes) heated by steam; when properly melted the whole is passed through a wire gauze strainer "into another vessel similarly heated"; three-fifths by weight of Gutta-percha, having by preference been previously cleansed in the ordinary way, and reduced into thin pieces or shreds, is then put into the heated vessel and mixed with the resin and tar. In this second vessel are stirrers, for mixing the whole uniformly.

Leonard Wray's cable compound was made of 1 part Gutta-percha, 4 parts India-rubber, 2 parts shellac, 2 parts flour of glass. This was used for underground wires.

Gaullie combined Gutta-percha with Roman cement by means of animal gall, forming a plastic material, capable of being stamped and molded.

Cooley mixed Gutta-percha with resin oil under heat, then mixed in carbonate of soda with roasted starch. To this compound he added asphalt to make it harder, or hyposulphite of lead, to make it softer. He also made a great many Gutta-percha compounds in which salts were present. These he steeped in water after mixing until they became soft and flexible.

Charles Macintosh made a compound for telegraph wire from Gutta-percha, naphthaline, and lampblack.

Charles Hancock boiled Gutta-percha in muriate of lime, passed it between heated cylinders, sifting the surface with rosin, in the production of a compound for complete insulation. Another of his compounds was made of Gutta-percha, shellac, and borax. He also made Gutta-percha sponge by mixing with it carbonate of ammonia or alum and applying heat. He also made a hard Gutta-percha which was similar to vulcanite by mixing it with sulphur, putting it in molds and keeping the compound at a high temperature for several days.

Duncan invented a great many compounds for Gutta-percha cement, many of which are now in general use. One suggestion of his was the mixing of Gutta-percha with Canada balsam and shellac, the resultant compound being a good cement capable of standing considerable heat and in no danger of becoming greasy on its surface.



Robert Hutchinson claimed that he was able to render Gutta-percha less liable to oxidize, to improve its elasticity, increase its tenacity, and diminish its liability to become sticky or tacky, by compounding it with lanichol or wood cholesterin. (See Lanoline.) Forster deodorized Gutta-percha by mixing with it essential oil, orris root, or gum benzoin.

Liquid Gutta-percha is Gutta-percha dissolved in chloroform, to which a little carbonate of lead is added in the shape of a fine powder. After agitation, the mixture is set aside until the insoluble matter has settled. The clear liquid is then decanted.

Spill, in order to prevent Gutta-percha that had been vulcanized from being attacked by grease, treated it to a solution of melted beeswax, hardening this coating with an infusion of nutgalls. Godefroy mixed Gutta-percha with powdered cocoanut shell, claiming that it would stand a higher degree of heat, and was considerably more elastic. Day, in America, mixed pipe clay with Gutta-percha that is being vulcanized in order to prevent its sponging.

The vulcanization of Gutta-percha, in spite of a common impression to the contrary, is something that can be easily accomplished, and is analogous to the vulcanization of India-rubber. It can be done by mixing with free sulphur or sulphides that contain free sulphur, or by the use of chloride of sulphur. As the Parkes mixture attacks Gutta-percha very easily, the dipping for vulcanization must be very quick, the article being then allowed to remain in the air for some hours. The second dip can be a little longer, as the surface is less easily attacked than before. The vulcanized product is quite hard and will stand a high degree of heat. Chloride of sulphur mixed with bisulphide of carbon can also be incorporated in a solution of Gutta-percha and bisulphide of carbon, with the result that the Gutta-percha will be thoroughly vulcanized.

The late Robert Dick, of Glasgow, who was a successful manufacturer of Gutta-percha articles in the mechanical line, produced many vulcanizable compounds of Gutta-percha of great value, some of which follow. He claimed that his compounded Gutta-percha retained the good qualities of the gum; that is, that it was homogeneous and plastic at a moderate heat, but tough and

hard at ordinary temperatures, and that it was just as valuable afterwards for mixing and molding over again.

Compound No. 1 is described as the hardest and toughest, and may be used, in place of leather and vulcanized India-rubber, for tires, belts, pulley coverings, horse shoes, etc. No. 2 is softer and more elastic, and suitable for soles and heels of shoes, wringer rolls, springs, playing balls, mats, etc. These goods are mixed in the usual way, and vulcanize in the masticator, but not enough to take away the plastic qualities of the Gutta-percha. For treating this compound, a special masticator was devised by Mr. Dick, the rolling cylinders being hollow, and a Bunsen gas burner inserted through one end of the hollow axle, while the gases pass off at the other, thus heating both roller and mixture. The outer cylindrical masticator is jacketed and heated with steam:

## COMPOUND NO. 1.

Pure cleaned hard Gutta-percha .....	28
Pure cleaned tough selected Gutta-percha or Balata (preferably more rather than less) .....	11
Pure cleaned "low white" Gutta-percha (preferably less rather than more) .....	9
"Crumb" or ground good old vulcanized India-rubber .....	34
Hardwood veneer dust .....	5
Sulphur .....	6½
Zinc oxide (or zinc dust) .....	3½
Flocking, or the cut fiber of cotton textile fabrics .....	3½
Total .....	100

## COMPOUND NO. 2.

Pure cleaned tough Gutta-percha .....	8½
Pure cleaned Balata or selected Gutta-percha .....	8½
Pure cleaned "low white" Gutta-percha .....	24
"Crumb" or ground good old vulcanized India-rubber .....	33
Hard ground veneer dust .....	5
French chalk, powdered .....	6
Sulphur .....	6
Zinc oxide (or zinc dust) .....	3
Flocking, or the cut fiber of cotton textile fabrics .....	3
Alum, ground .....	3
Total .....	100

Another compound patented by Mr. Dick embraced the use of low grade African and Borneo rubbers, which, after cleansing, were mixed with gutta-percha while still moist in hot water. After the mixing the compound is treated under a moist heat, where the temperature is 212° to 240° F., the result being a

tough, plastic, fibrous dough. This compound is then, so the inventor claims, equal to any service for which the Gutta-percha and Balata compounds are used. An important property in this compound is the shrinking quality which Gutta-percha possesses, while its power of cohesion rendered it especially valuable for insulating wires.

Shepard mixed Gutta-percha with sulphur, exposed it to a heat varying from 300° to 350° F., admitting hot air, then combined it with sulphur and earthy matters. It was then vulcanized by Parkes's cold curing process.

Parkes dissolved Balata and mixed it with 5 per cent. of chloride of sulphur, diluted with mineral naphtha. Gun cotton was also dissolved to a pasty mass, in naphtha distilled with chloride of calcium, and the two solutions were combined, forming a soft, flexible compound.

Childs vulcanized Gutta-percha by mixing it with sulphur and placing it in a vulcanizer containing hydrated lime, and then turning on heat sufficient to obtain enough steam from the lime to do the curing.

Duvivier and Chaudet treated Gutta-percha with bromide of sulphur or chloride of sulphur, making it more elastic and less liable to be acted on by heat or cold. When acid vapors were formed during the operation, carbonate of sodium was mixed with the solution.

Rostaing made Gutta-percha hard and unalterable by treating it, after cleansing, with caustic soda, which was thoroughly washed out, after which it was combined with silicate of magnesia and treated with tannin, catechu, and other astringent matter.

Keene cured Gutta-percha articles by exposing them to the fumes of sulphur or immersing them in a bath of melted sulphur.

Charles Hancock treated Gutta-percha in a bath of boiling water in which was carbonate of potash, or muriate of lime, leaving it for an hour, and then mixing it with lead, glue, and bitumen. His claim was that this treatment hardened the Gutta-percha, rendered it better adapted for bearing friction, and less likely to be oxidized. He also cured Gutta-percha by mixing with it sulphur, sulphides or orpiment, and applying heat. He gave as a compound for vulcanizing Gutta-percha 48 parts Gutta-

percha, 6 parts golden sulphuret antimony, and 1 part sulphur, the compound to be boiled under pressure.

Emory Rider mixed Gutta-percha with oxide of lead, heated it in open steam heat until the oily matters were expelled, then mixed it with hyposulphite of lead and cured it.

Lucas prepared a printing roll of Gutta-percha, first immersing the Gutta-percha in nitric acid, and then placing it for an hour in a solution of carbonate of soda, thus producing a tougher wearing surface.

Barlow and Forster mixed Gutta-percha with kauri gum and milk of sulphur for a cable coating.

Macintosh immersed Gutta-percha in concentrated sulphuric acid for a number of seconds to harden the surface. He also mixed Gutta-percha with gun cotton, curing with sulphuric acid, claiming that the resultant compound was not likely to be affected by the heat of tropical climates.

Analyses of common Gutta-percha, by Edouard Heckel and Fr. Schlagdenhauffen:

Gutta .....	75	to	82
Albane .....	19	to	14
Fluavile .....	6	to	4
Total .....	100		100

Analysis by Payen:

Gutta .....	78	to	82
Albane .....	16	to	14
Fluavile .....	6	to	4
Total .....	100		100

Gutta-percha is made of a mixture of hydrocarbons, and there is usually present a certain amount of oxygen. According to Granville H. Sharpe, F.C.S., its ultimate composition is:

Carbon .....	86.36
Hydrogen .....	12.15
Oxygen .....	1.49
Total .....	100.

[Specific gravity, 0.96285 to 0.99923.]

The primary analysis of Gutta-percha by Sharpe is:

Hydrocarbon .....	79.70
Resin .....	15.10
Wood fiber .....	2.18



Water .....	2.50
Ash .....	0.52
Total .....	100.

Obach gives the following average results from a large number of analyses of each of twelve leading brands or sorts of Gutta-percha:

	Gutta.	Resin.	Dirt.	Water.
Pahang .....	78.1	19.2	1.5	1.2
Banjer red .....	67.0	30.2	1.5	1.3
Bulongan red .....	68.6	29.0	1.4	1.0
Bagan .....	57.5	40.9	1.0	0.6
Goolie red soondie .....	55.2	42.9	1.2	0.7
Serapong .....	56.2	42.4	0.9	0.2
Bulongan white .....	52.2	45.4	1.5	0.9
Mixed white .....	49.8	47.4	1.1	1.7
Banjer white .....	51.8	44.1	1.8	2.3
Sarawak mixed .....	55.6	40.9	1.8	1.7
Padang reboiled .....	50.3	45.8	2.0	1.9
Banca reboiled .....	46.8	51.1	1.1	1.0

Another series of analyses by Obach relates to the constitution of the resins in Gutta-percha, as follows:

	Albane.	Fluavile.
Carbon .....	78.76	80.79
Hydrogen .....	10.58	11.00
Oxygen .....	10.46	8.21
Total .....	100.	100.

Some typical Gutta-percha cement compounds follow:

1.—For joining wood: Gutta-percha, 11 pounds; shellac, 3 pounds; Venice turpentine, 5 pounds; pitch, 1 pound.

2.—For uniting metals, glass, stone, and earthenware: Gutta-percha, 45 pounds; shellac, 20 pounds; gum mastic, 5 pounds; oxide of lead  $\frac{1}{2}$  pound; storax, 3 pounds; Venice turpentine, 26 $\frac{1}{2}$  pounds.

3.—For cementing leather: Gutta-percha, 4 ounces; bisulphide of carbon, 20 ounces; asphaltum, 1 ounce; common resin, 1 ounce.

4.—Gutta-percha glue: Gutta-percha, 1 pound; rosin, 1 pound; litharge, 1 ounce; powdered glass, *quantum sufficit*.

5.—Shoemaker's wax: Melt Gutta-percha, 20 ounces; add pitch, 58 ounces; soap, 5 ounces; rosin, 6 ounces; beeswax, 5 ounces; palm oil, 1 ounce; tallow, 5 ounces.

6.—For preserving metals and other surfaces: Coal tar, 20

pounds; Gutta-percha, 5 pounds; minium, 6 pounds; white lead, 7 pounds; pitch, 10 pounds; resin, 10 pounds; spirit turpentine, 4 pounds; sulphur, 38 pounds.

7.—General cement: Make a solution of Balata of 5 ounces in  $\frac{1}{4}$  gallon naphtha, and another of Gutta-percha 5 ounces in  $\frac{1}{4}$  gallon naphtha. Combine the two solutions and add 13 ounces resin or pitch and stir and mix thoroughly.

"Gentsch's Gutta-percha" is a widely used substitute for Gutta-percha, made in general as follows: The ingredients used are mineral wax, tar, resin, and rubber. The process is thus described by a scientist who visited the English factory: A mixture of resin, wax, and tar was thrown into a kneading machine, steam being applied from below, to keep the temperature at the proper point. Twenty minutes later, the mass having been kneaded meanwhile, the steam was turned off and the rubber (cut into small pieces) added, being fed in slowly to prevent jamming of the knives of the kneading machine. The machine was stopped from time to time to test the condition of the mass, and at the end of three hours the solution of the rubber was found to be complete and the mass was removed from the machine and passed between rollers, coming out in slabs  $\frac{1}{4}$  inch thick—the finished material.

#### THE ANALYSIS OF GUTTA-PERCHA.

THIS of course refers to the analysis for the crude gum, and, to have the analysis complete, it should cover the amount of water present, the amount of foreign matters and impurities, the amount of ash, the amount of pure gutta, and the amount of resins.

The water is easily determined by heating a known weight from the sample at a temperature ranging from 212° to 230° F., the loss in weight being the amount of water present. This is a common process in chemical analysis. In the case of Gutta-percha, it must be varied, as the sample is liable to oxidize even under examination, causing an increase of weight. This is overcome by conducting the heating in a slow current of nitrogen, or carbonic acid gas.

J. A. Montpellier devised an apparatus for this, which consisted of a special retort with a large opening which he used as a

vapor bath and having a tubulure at its side. It is closed by a large cork, in which there are two holes, one for the tube which is to introduce the gas, and the other for the thermometer. The sample to be dried is placed in a crucible of porcelain or platinum suspended within the retort. As the water evaporates it is borne by the current of gas through a tube inserted in the side tubulure, and into U-shaped tubes, containing sulphuric pumice, which retain it. Further on the U tubes are connected with a Liebig tube with five bulbs containing pure sulphuric acid preventing the entrance of moist air after the apparatus cools, a further use being to make it possible to regulate the speed of the current of gas.

The retort is immersed in an oil bath heated by a Bunsen burner. If carbonic acid be used it is obtained by the action of hydrochloric acid on marble chips produced in a Kipp apparatus followed by wash flasks, the first of which contains bicarbonate of potassium in solution, which is intended to stop the passage of any hydrochloric acid, and the second containing sulphuric acid at  $150^{\circ}$  to thoroughly dry the gas. To be absolutely sure that this gas is dry a dessicator filled with sulphuric pumice is placed between the retort and the second wash flask. The operation of drying one gram with this apparatus takes 6 or 7 hours. The determination of the amount of impurities, which comes next, may be effected very easily, by using M. F. Jean's exhaust apparatus. A small part of the sample, from one-half a gram to a gram, is weighed, cut into small fragments, put in a filter, the weight of which is known, which in turn is placed in a platinum cone. This cone is then put in the extension of the apparatus; this extension communicates by two tubes with the retort containing pure chloroform. A condenser, in which a current of cold water constantly circulates in order to condense the chloroform vapor, is placed at the upper part of the extension.

The retort rests on a sand-bath, very gently heated by a Bunsen burner. Under the influence of the slight heat the chloroform evaporates, passes through one of the tubes, and drops on the filter containing the Gutta-percha, which it gradually dissolves. The solution, passing through the filter, then drips into the retort through the second tube.

All the impurities remaining in the filter, it is sufficient to dry and weigh the filter to get the weight of the foreign matters, the drying should be done in the apparatus used in determining the amount of water.

The next process is the determination of the amount of ash. In Gutta-percha this is always very small, as mineral matter is almost entirely absent from it, the quantity never exceeding one-half of 1 per cent. The amount of ash is determined by burning in a capsule of platinum or porcelain a known weight of Gutta.

The fourth step is the determination of the amount of pure gutta, and of the resins. Both fluavile and albane are soluble in absolute alcohol at the boiling point, and as pure gutta is insoluble in it, this is a very ready means of separation. The sample to be examined is cut in little bits, put in a platinum basket which is pierced with holes, and hung in a retort containing the alcohol. This retort is heated with a sand-bath or water bath, the vapor of the alcohol passing through a Liebig condenser and returning to the retort. The boiling is continued for 5 or 6 hours, with the basket immersed in the alcohol. It is then raised above the liquid, and the boiling continued for 5 or 6 hours more. The latter part of the process removes the last traces of resin.

The boiling operation being completed, the pure gutta together with the impurities remains on the filter. There remains then the drying of the filter in the apparatus used in determining the amount of water and the weighing of it. The loss of weight shown by the Gutta-percha corresponds to the amount of resins increased by the weight of the water. Subtracting that weight, already determined, the weight of the resins remains.

Wilton G. Berry, Ph.B., is the author of a monograph on the analysis of Gutta-percha resins, the basis of which was a paper read before the Society of Chemical Industry. In it he dealt with the comparative quantitative analyses by treatment of the previously dried material with acetone, alcoholic-potash, and petroleum ether, and extraction of the resins in a uniform manner with boiling absolute alcohol, and the separation of the thus extracted resins into their component resins, soluble and insoluble in cold absolute alcohol.

The object was the determination of—



Saponification value,  
 Acid value,  
 Ether value,  
 Iodine value,  
 Acetyle value,  
 Methyl value,  
 Melting point, solubility, etc.,

—of the individual resins, hoping thus to establish a table of values whereby the resins of any given specimen may be identified and the identity of the parent gum thus established. The gums thus far experimented on are a few specimens each of Gutta-percha, Chicle, Almeidina, Tuno, Jelutong (Pontianak), Balata, and *Payena* sp.

It has been found thus far that the resins from several specimens of the same gum have practically the same constants and characteristics, and that the resins from the different species of gums have different constants and characteristics—in some widely different, and in the cases of the gums above cited sufficiently differing to make identification of their parent gum an easy matter. From the gums so far examined it is hoped to establish the fact that the combined evidence of the constants and characteristics of the resins, together with the character of the accompanying hydrocarbons, will show that each species of gum varies from each other sufficiently to make differentiation of unnamed specimens complete, and to establish the fact that every specimen of the same species of gum is alike in the characteristics quoted.

## RESUME OF ANALYTICAL WORK.

*Gutta-percha*.—Resins soft, pasty, yellow.

*Chicle*.—Resins hard, grayish yellow, brittle.

*Tuno*.—Resins hard, dark yellow, brittle.

*Almeidina*.—Resins hard, brittle, yellow.

*Jelutong*.—Resins soft, brittle, yellow.

*Balata*.—Resins turbid liquid, yellow.

*Payena*.—Resins similar to Chicle resins.

	Saponification value.	Acid value.
*Gutta-percha resins	78.5	5
*Gutta-percha (albane)	83.5	—
*Gutta-percha (fluavil)	71.45	—
*Chicle resins	103.1	Trace
Chicle (resin A)	129.0	Trace
Chicle (resin B)	100.8	Trace
†Tuno resins	77.3	5.6
†Jelutong	77.5	Trace
Almeidina	50.4	11.0
Balata	69.2	Trace
†Payena sp	103.7	Trace

\* Average of 4 specimens. † Average of 2 specimens.

While the saponification values of Gutta-percha, Tuno, and Jelutong resins respectively are almost identical, their separation into component resins corresponding to albane and fluavil of Gutta-percha gives entirely different results from the latter and from each other. The resins of Chicle and *Payena* differ as widely and the accompanying hydrocarbons are quite different.

#### BALATA.

BALATA is the gum of the "bully" or "bullet" tree—the *Mimusops balata*—found in British and Dutch Guiana, and in Venezuela. It is marketed in two forms, "block" and "sheet." The sheet is usually worth about 30 per cent. more than the block Balata. The sheet is used for belt covering, while the block is more used in compounding. Balata is usually reddish gray, though sometimes brown. The dried sheet milk or sheet product usually contains 39 per cent. gutta and 37 per cent. rosin; while the boiled or block contains 51 per cent. gutta and 48 per cent. rosin. The sheet shrinks from 10 to 20 per cent. while the block shrinks from 20 to 30 per cent.

The balata tree may be tapped when 5 inches in diameter. If tapped too deep, the tannin sap injures the product, and the wound is slow to heal. The outer bark is removed before tapping. The milk runs for about three hours, and a tree will generally yield about 3.6 liters of milk, or 1½ to 2 kilos of Balata. It usually requires about two weeks for the milk to dry.

In character this gum occupies a position between India-rubber and Gutta-percha, combining in a degree the elasticity of one with the ductility of the other, and freely softening and becoming plastic and easily molded in hot water. Balata is dried ordinarily by evaporation. A more rapid coagulation is effected by the use of spirits of wine. Alum is sometimes used to coagulate, but is not very satisfactory. The gum is sometimes mixed during the gathering with the milk that produces gum known as Touchpong and Barta-Balli. It is used principally in the manufacture of belting and for insulation work. It has been utilized also for golf balls and as a substitute for rubber in dress shields.

MURAC is a commercial product resulting from the treatment by a chemical process of the latex of certain plants of the *Sapotaceæ* family, as Balata, for example. Made in England.

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[From a report on the International Rubber and Allied Trades Exhibition, in London, from *The India-Rubber Journal*.]



TYPKE & KING'S DISPLAY  
International Rubber Exhibition at London

The exhibit of this company was one of the features of the Exhibition, the arrangement of the stand and show cases was unique, and called forth commendations from all who inspected the display.

For more than twenty-five years the firm has made a special study of the requirements of the rubber trade. Its large works are at Mitcham Common, Surrey, and Rainham, Essex, and the company now has agents in Manchester, Birmingham, Edinburgh, Belgium, France, Germany, United States, Russia, Canada, and Japan.

Of the articles exhibited we noticed particularly the golden and crimson antimonies, several shades of the latter being shown; the outstanding feature of this company's antimonies is that the percentage of free sulphur is always the same, and the user is therefore able to obtain regular results. Samples of rubber sheet, bat handles, tubing, etc., were on view, actually made from these antimonies, and were pronounced to be very fine indeed.

A good collection of india-rubber substitutes was made by the company. Of the white there were the special for mixing for proof-

ing purposes, a quality which has been in use for very many years and has always given uniform results, and the ordinary white substitutes, S.O. and S.O.O., for mechanical goods, tubing, sheeting, etc. There were also white and black snow sorts; the last-named is made by this company alone, and is intended for mixing with rubber for the manufacture of cut sheet. A new kind of dark substitute, to which the company has given the name "Parateka," was also shown; this is reputed to be the lightest on the market, having a specific gravity of 0.9042.

There were also coloring substitutes in red, orange and yellow shades for heightening the color of rubber goods. They were pronounced quite free from acid.

Black hypo and special black pigment, specially prepared for mechanical and piece goods respectively, were also displayed. These are always uniform in composition and percentage of free sulphur.

The firm showed a fine set of tennis shoe soles in yellow, blue, green, red and black, made with their colors, which were greatly admired. The same shades are also made for enamel work.

The special grades of vegetable black are very fine; the "Extra" is an intense black, very light, and can be used in small proportions.

Finest pure sulphur is another specialty; being perfectly neutral it is suitable for rubber work.

Zinc sulphide was shown in white and yellow shades; the company have a new quality of white testing 98 per cent. that is of very fine texture.

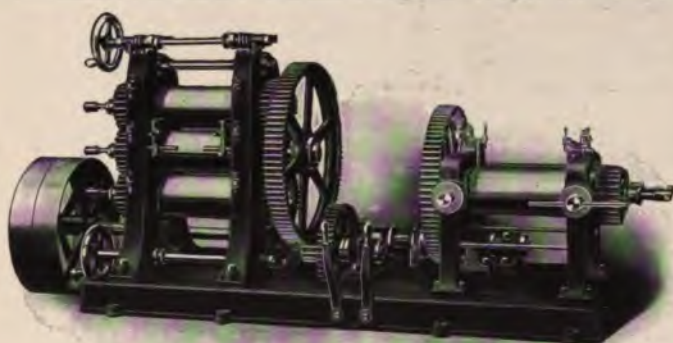
Among other articles exhibited were vermilion, of various shades; pure fine lime, plumbagine for oil resisting valves; scarlet stain for cheap red goods; carbon tetrachloride, absolutely unflammable; precipitated chalk very fine, white and light; barytes, French chalk, lithopone, calcined magnesia, carbonate of magnesia, pure precipitated sulphur, sublimed lead, and zinc oxides in all qualities.

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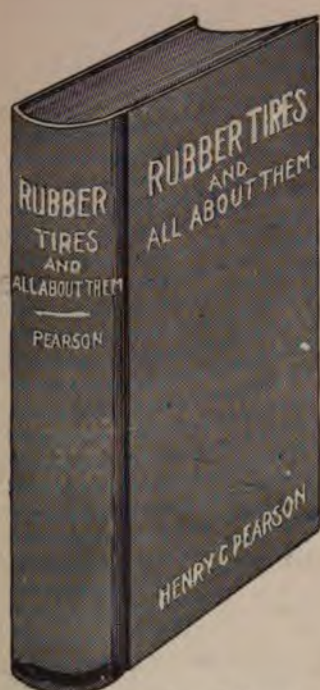
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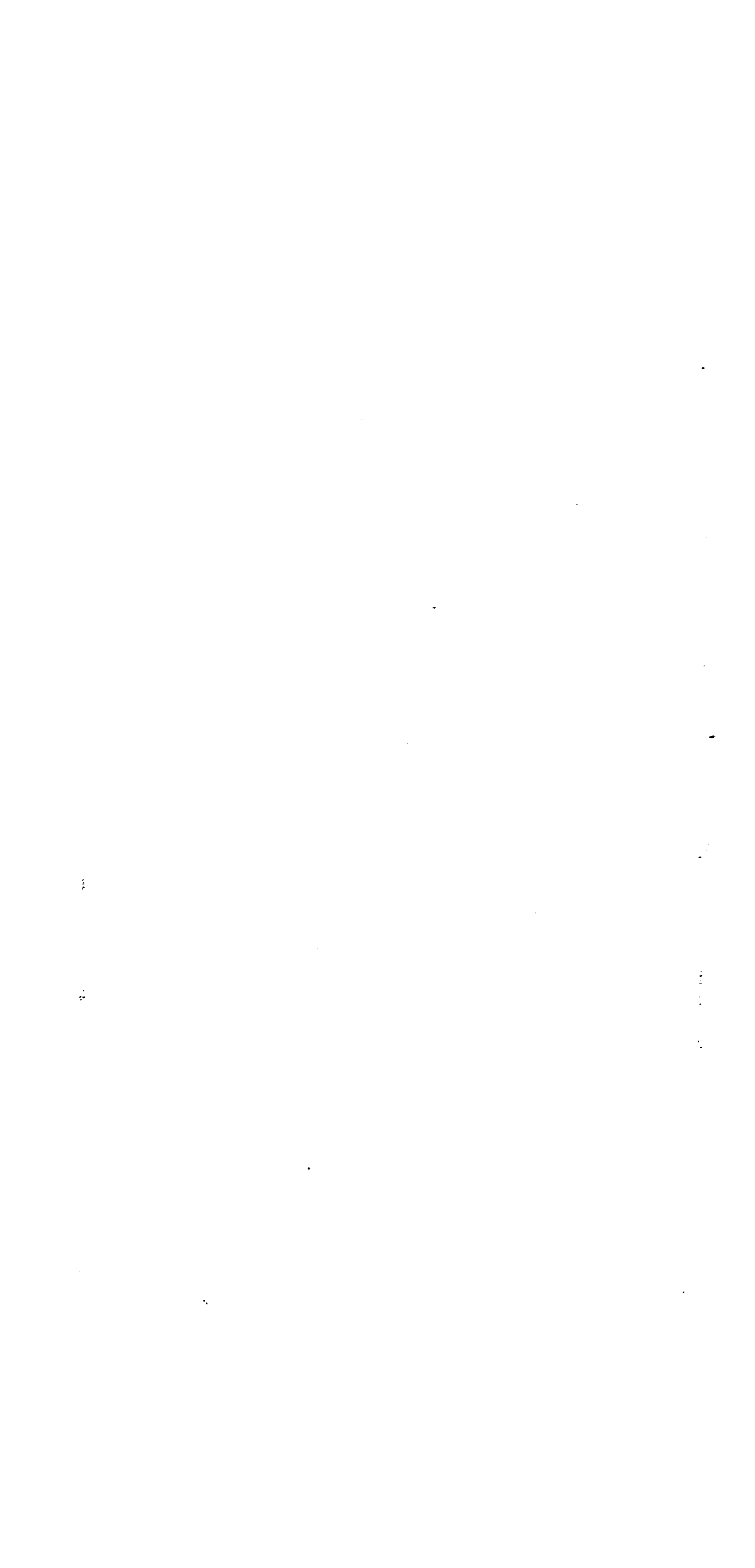
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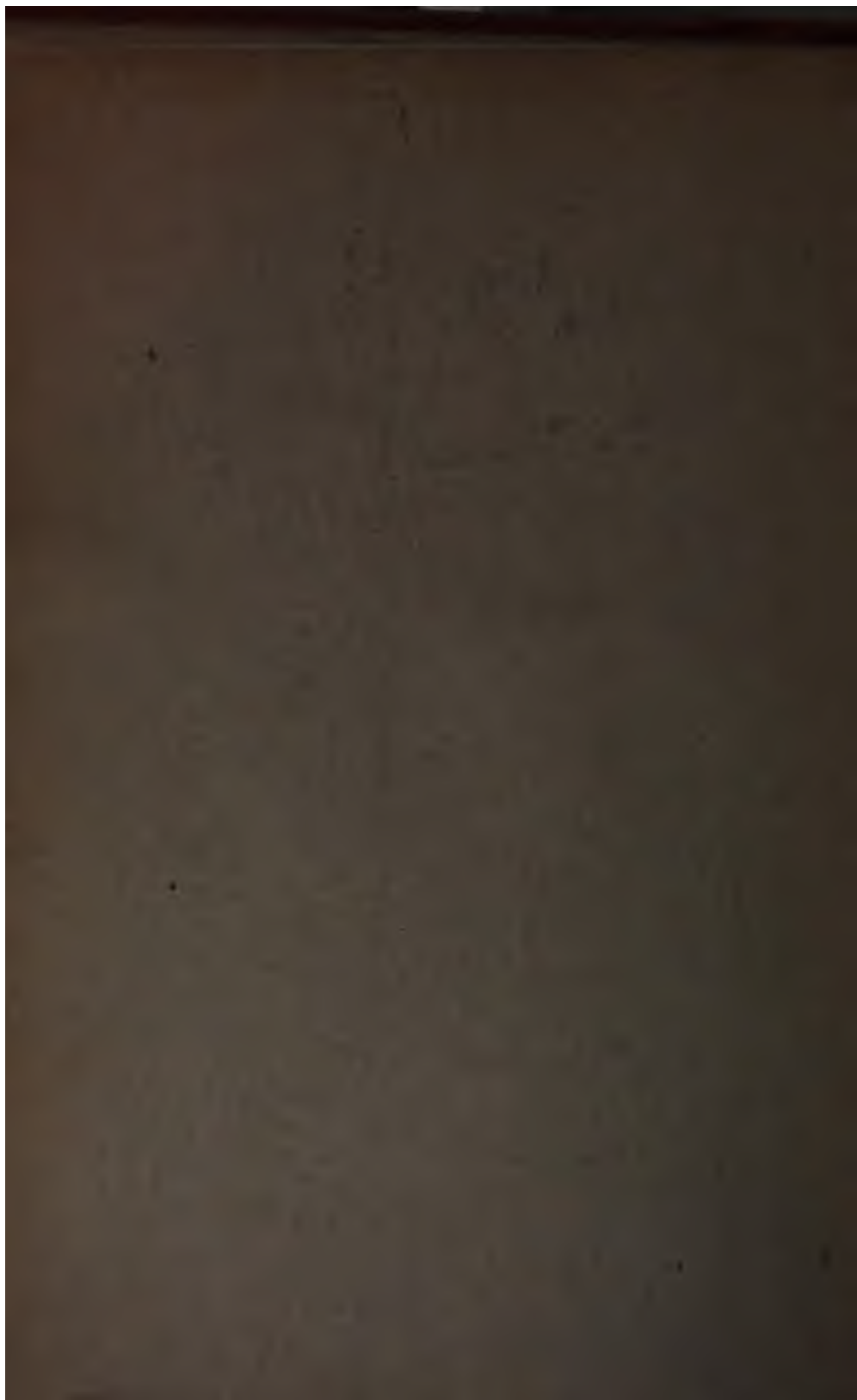
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